PB-216 468

TRI-STATE SURVEY OF LAKE MICHIGAN WATERS,

Environmental Health Center
Cincinnati, Ohio

1948

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 216 468

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

T R I - S T A T E S U R V E Y

O F

L A K E M I C H I G A N W A T E R S

1948

PRELIMINARY REPORT

Reports Assembled by:
Environmental Health Center
Cincinnati, Ohio

I

CONTENTS

REPORT

		Page
I	Introduction	
	Origin	1
	Advisory Board	
	Purposes of Survey	
	Cooperating Groups	
II	General Summary and Conclusions	
	General Findings	4
	Enterococcus Group as Pollution Indicator	
	Frequency of Bacteriological Sampling	
	Special Studies	
III	Field Procedures	
	Sanitary Surveys	7
	Climatological Data	
	Sampling	
	Bathing Loads	
	Lake Conditions	
IV	Laboratory Procedures	
	Summary of Routine Procedures	9
	Coliform Tests	
	Enterococcus Tests	
	Enterococcus Studies at Cincinnati	

APPENDICES

A	Survey in Wisconsin	
	Conclusions	11
	Sample Points	
	Sanitary Conditions	
	Laboratory Examinations	
	Discussion	
B	Survey in Illinois (Lake County)	
	Conclusions	18
	Sample Points	
	Sanitary Conditions	
	Laboratory Examinations	
	Discussion	
C	Survey in Illinois (Cook County)	
	Conclusions	25
	Sample Points	
	Sanitary Conditions	
	Laboratory Examinations	
	Discussion	

I b

D Survey in Indiana 33
Conclusions
Sample Points
Sanitary Conditions
Laboratory Examinations
Discussion

TABLES

		Following page
Wisconsin		
1	Sample Points	13
2	Bacteriological Results - Frequency Distribution	16
3	Bacteriological Results - Densities	16
Lake		
1	Sample Points	20
2	Bacteriological Results - Frequency Distribution	23
3	Bacteriological Results - Densities	23
Cook		
1	Sample Points	26
2	Bacteriological Results - Frequency Distribution	29
3	Bacteriological Results - Densities	29
Indiana		
1	Sample Points	34
2	Bacteriological Results - Frequency Distribution	37
3	Bacteriological Results - Densities	37

FIGURES

1	General Map	1
Wisconsin		
1	Relation of Coliform and Enterococcus	16
2	Medians of MPN Values	16
Lake		
1	Relation of Coliform and Enterococcus	23
2	Medians of MPN Values	23
Cook		
1	Relation of Coliform and Enterococcus	29
2	Medians of MPN Values	29
Indiana		
1	Relation of Coliform and Enterococcus	37
2	Medians of MPN Values	37

I - INTRODUCTION

The Tri-State Survey of Lake Michigan Waters was made with particular emphasis on the quality of bathing waters. The purpose of this preliminary report is to give a brief outline of the origin of the survey and its objectives, a brief description of the methods and techniques used, the general location of each sampling point, summaries of sanitary surveys and laboratory results, and preliminary conclusions which can be drawn from the data presented. It is hoped that this report will serve a useful purpose in keeping the many communities along the Lake Michigan shoreline in Wisconsin, Illinois, and Indiana informed as to the status of the survey.

Due to the substantial task involved in the statistical analysis of the epidemiological data obtained in the Chicago area and in the correlation of physical observations with bacteriological data, these phases of the study, as well as a discussion of bathing water standards, will be covered in a more comprehensive supplemental report to be made at a later date.

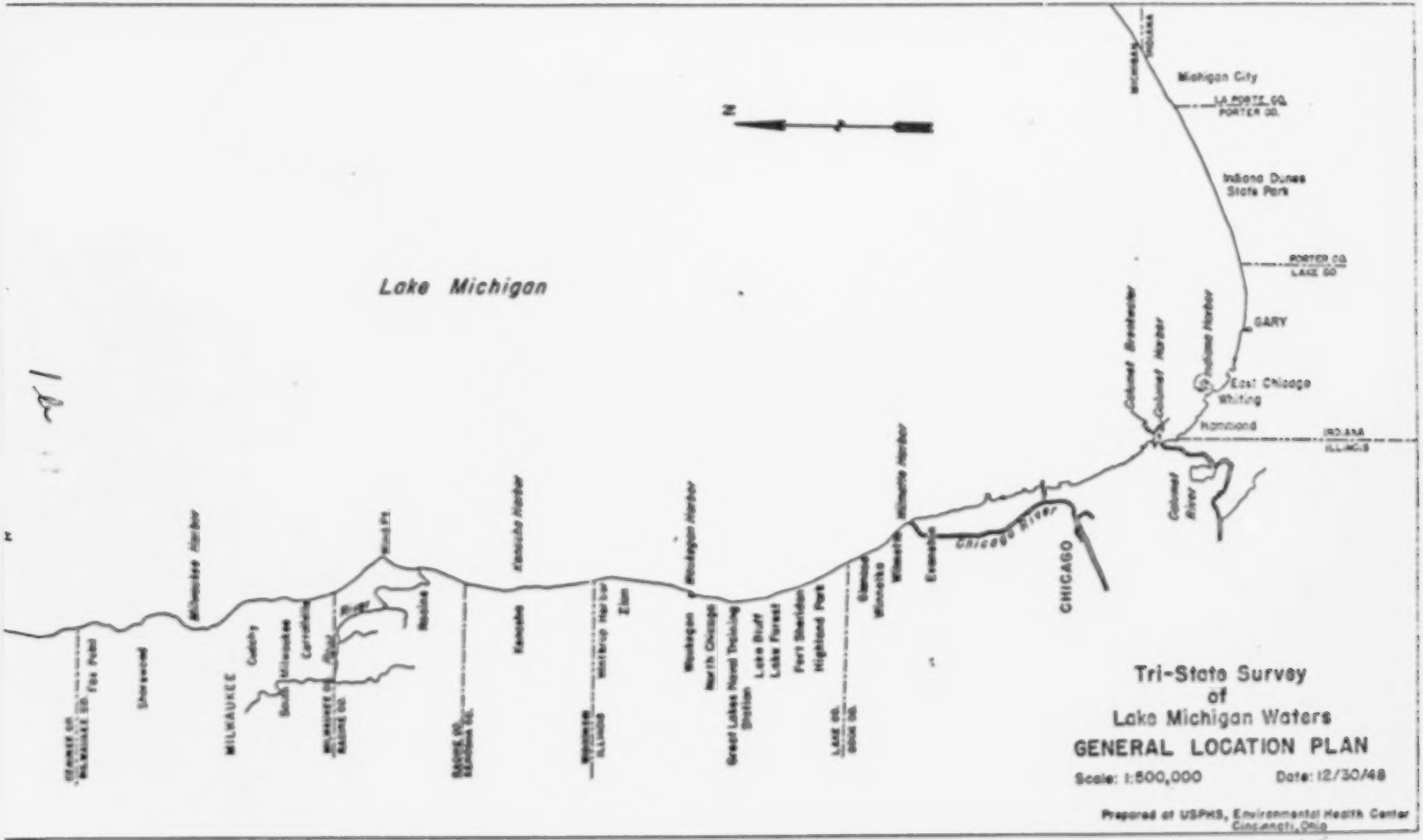
Origin of Survey

The survey was developed as a cooperative undertaking after an intense interest in the quality of bathing waters had been shown by the Chicago Park District and the several shore front municipalities in Lake County, Illinois, following a survey in that county by the Illinois Sanitary Water Board in 1947. A conference was held in Chicago, January 30, 1948, at which many of the agencies which later participated in the survey were represented. The Illinois Sanitary Water Board representatives indicated that they planned to make a resurvey of Lake County shore waters in 1948. The U. S. Public Health Service expressed its interest in the study of fundamental problems concerned with bathing beach survey techniques and methods and particularly in the need for epidemiological evidence toward the development of sound bathing water standards. At future conferences the interest of Wisconsin and Indiana communities in the adjacent Lake Michigan bathing waters was expressed by representatives of the respective State Boards of Health. Consequently, the survey was planned to include the entire Lake Michigan shore line from Milwaukee, Wisconsin, to Michigan City, Indiana. (Figure 1 shows the area covered by the survey.)

Advisory Board

An Advisory Board was formed to plan and consolidate the program of study and to adopt the policies to be followed in carrying out the survey. Each major participating agency designated representatives to this Board. They included:

Chicago Board of Health	Dr. Samuel Hyman Chief Medical Officer
Chicago Department of Public Works	Mr. J. R. Baylis Engineer of Water Purification
Chicago Park District	Dr. L. B. Gordon Medical Director


Lake Michigan
Michigan City
LA PORTE CO.
PORTER CO.
Indiana Dunes State Park
PORTER CO.
LAKE CO.
GARY
Indiana Harbor
East Chicago
Whiting
Hammond
INDIANA
ILLINOIS
Calumet Breakwater
Calumet Harbor
Calumet River
Chicago River
CHICAGO
Evanston
Wilmette Harbor
Glencoe
Winnetka
Highland Park
Fort Sheridan
Lake Bluff
Lake Forest
Great Lakes Naval Training Station
Waukegan
North Chicago
Waukegan Harbor
Zion
Winthrop Harbor
Kenosha Harbor
Racine
Racine Co.
Kenosha Co.
Milwaukee Co.
Racine Co.
Cudahy
South Milwaukee
Caroline
Milwaukee
Shorewood
Fox Point
Milwaukee Harbor
MILWAUKEE
Tri-State Survey
of
Lake Michigan Waters
GENERAL LOCATION PLAN
Scale: 1:500,000
Date: 12/30/48
Prepared at USPHS, Environmental Health Center
Cincinnati, Ohio

Cook County Department of Public Health	Dr. E. A. Piszczek Director
Sanitary District of Chicago	Dr. F. W. Mohlman Director of Laboratories and Mr. Langdon Pearse Sanitary Engineer
Wisconsin Board of Health	Mr. L. F. Warrick State Sanitary Engineer
Indiana Board of Health	Mr. B. A. Poole, Director Bureau of Environmental Sanitation
Illinois Sanitary Water Board	Mr. C. W. Klassen Technical Secretary, Chairman
U. S. Public Health Service	Mr. A. L. Stevenson Sanitary Engineer, Technical Secretary

The board held monthly meetings prior to and during the course of the survey. Several of its members provided active general supervision over the field activities.

Purposes of the Survey

The essential objectives of this survey were stated to be:

(1) The determination of the physical, chemical, and particularly the bacteriological quality of the waters tributary to and at the bathing areas.

(2) The investigation of the physical factors which influence the water quality and the changes in water quality.

(3) The study of the suitability of the use of the enterococcus group of organisms as a supplement to the coliform group as a bacterial indicator of pollution.

(4) The study of the effects of bathing loads upon the water quality.

(5) The accumulation of epidemiological data on diseases or irritations attributable to bathing which might lead to the establishment of more definitive water cleanliness standards.

Cooperating Groups

The survey was divided into four geographical parts for most efficient supervision and operational control. The Public Health Service was charged with

responsibility for the technical coordination of the work and served as the central clearing agency for the project.

The first section embraced the Wisconsin counties of Milwaukee, Racine, and Kenosha. Mr. A. P. Stivarius, District Engineer of the State Board of Health, coordinated the work in these areas. The collection of samples and laboratory examinations was made by personnel of the Milwaukee Department of Public Health, the Racine sewage treatment plant, and the Kenosha city (State cooperative) laboratory.

The second section embraced Lake County, Illinois, and was directed by Mr. R. S. Nelle, Sanitary Engineer, and Mr. Robert Scott, Bacteriologist, of the Illinois Sanitary Water Board. Laboratory facilities were furnished by the Great Lakes Naval Training Center. Many of the county municipalities and the North Shore Sanitary District made laboratory examinations of the water quality also.

The third section embraced Cook County, Illinois, and was under the direction of Mr. Russell S. Smith, Public Health Engineer, and Mr. Harold P. Clark, Bacteriologist, of the Environmental Health Center of the Public Health Service. Laboratory facilities and services were provided by the Chicago Department of Public Works at the South District Filtration Plant. Office space, automotive equipment, excellent personnel for sample collection, laboratory work, and epidemiological studies, and other valuable services were provided by the Chicago Park District. The Sanitary District of Chicago provided valuable basic data on the sanitary conditions along the entire county lake front.

The Cook County Department of Public Health provided valuable assistance in the educational program, in the training of epidemiological workers and in furnishing assistants to carry on the epidemiological work. In particular, the work of Miss Irene Fahey, Health Educator, and Mr. Benn Leland, Sanitary Engineer, was most helpful. The Chicago Board of Health also furnished assistance in this phase of the work.

The fourth section embraced the Indiana lake shore bathing areas. This work was under the direction of Mr. G. G. Fassnacht, Sanitary Engineer, with the assistance of Mr. W. D. Shillinger, District Engineer, and Mr. M.S.A. Campbell, Bacteriologist, of the State Board of Health. Laboratory examinations were made at the Hammond Water Filtration Plant, the Gary Board of Health, the East Chicago Board of Health, and the Indiana State Board of Health laboratories. In addition check samples were examined at the State laboratory in Indianapolis.

In addition to the contributions of the major participating agencies previously noted, much useful information, maps and services were obtained from the Corps of Engineers, the Coast Guard, the Weather Bureau, the Chicago District office of the Public Health Service, the Lake Survey and the several municipalities which maintain water intakes in Lake Michigan within the area covered by the survey.

Dr. John J. Phair, Professor of Preventive Medicine at the University of Louisville, and Mr. Theodore D. Woolsey, Biostatistician of the Public Health Service, provided valuable advice and consultation to the survey as consultants on the epidemiological and statistical phases of the work.

II - GENERAL SUMMARY AND CONCLUSIONS

General Findings

A survey of the area showed wide variations in the sanitary conditions which could produce an effect on the water quality at the beaches. The descriptions and conclusions for each area are discussed in the reports of the respective cooperating units.

The United States Public Health Service has not recommended a nationwide standard for bathing water quality. However, for administrative reasons, many state health departments have adopted standards of bathing water quality based chiefly upon a correlation of the findings of the sanitary survey with the bacteriological quality of the water as measured by the density of coliform organisms present.

Pending further studies including the analysis of the epidemiological data obtained during this survey, it is not possible to interpret the survey findings in terms of water quality standards for bathing purposes. Further it is believed that observations in other places will be necessary prior to the ultimate development of definitive standards with assurance of their validity.

Accordingly, the areas studied have been arbitrarily separated into three categories; best, poorest and intermediate, on the basis of their relative bacterial quality. These gradations are not intended for use in establishing outdoor bathing water quality requirements for general application. The relative quality of the waters studied in this survey is reflected, however, by this procedure.

Within the limits of the foregoing discussion the following conclusions apply to the survey as a whole:

1. From the viewpoint of coliform water quality and freedom from pollution, the following shore water areas appear to be the best in the survey area.

    a. Indiana, east of Gary.

    b. Cook County, north of the Calumet Harbor breakwater, with few exceptions.

    c. Lake County, Illinois, at Cary (Sample Point 1, Table Cook 1), Central and Park Avenues, Highland Park; at Fort Sheridan; at Waterworks Bathing Beach, Waukegan; at Illinois State Beach Park; and at Camp Logan.

    d. Kenosha County, Wisconsin.

    e. Milwaukee County north of the Milwaukee water filtration plant.

2. The following beaches (not necessarily used for bathing) were of the poorest quality as judged by bacteriological examinations which are in general accord with the known existence of sources of pollution in these areas:

a. Indiana: Lake Front Beach, Hammond, and Municipal Beach, Whiting.

b. Cook County, Illinois: Calumet Park, Chicago.

c. Lake County, Illinois: Great Lakes Naval Training Center, North Chicago and Water Street, Waukegan.

d. Wisconsin: 14th Street Beach, Racine, and South Shore Park and Grant Park beaches, Milwaukee County.

3. The remaining beaches were of intermediate quality. While from the sanitary survey there are some sources of pollution, the bacteriological quality of these waters in many cases would meet the bathing water standards applied in many parts of the country.

Enterococcus Group as an Indicator of Sewage Pollution

The "Enterococcus Test" of Winters and Sandholzer was made simultaneously with the coliform examination on each sample. Without evaluation at this time of its usefulness as a pollutional indicator, the following summary describes the results:

1. The enterococcus group was isolated from most sample points at one time or another during the period of the survey, including areas where the sanitary survey showed no evidence of immediate sewage pollution.

2. In areas where the sanitary survey showed no evidence of immediate sewage pollution, the density of enterococcus was extremely low. Generally the results were negative in the largest portions examined, in frequent instances the most probable number of organisms exceeded 3.6, but rarely did they exceed 43. Thus the enterococcus-coliform ratio was generally indeterminate. Based upon median results the ratio varied from not less than 1 to 14.3 to not less than 1 to 104. The variation in the ratio for examinations of individual samples was, of course, much greater.

3. The enterococcus density was much higher in areas where fresh sewage or treated sewage effluent entered the waters of the area. The most probable number of organisms exceeded 3.6 more than 50 percent of the time, frequently exceeded 43, and in some instances exceeded 240.

4. The highest enterococcus densities occurred at the outlets of Pettibone and Sunderland Creeks in Lake County, Illinois. At these two points the density exceeded 240 per 100 ml in 60.4 percent and 33.3 percent of the samples examined.

5. In the Hammond-Whiting area (Indiana) the enterococcus densities were very low accompanied by extremely high coliform densities. On the basis of median results the enterococcus-coliform ratio was not less than 1 to 6500 at Whiting and not less than 1 to 56,000 at Hammond. Considereble industrial waste in relation to the amount of raw sewage enters the lake in this area. These apparently abnormal results may be due to the peculiar characteristics of an industrial waste which enters the lake near the Hammond Lake Front Beach.

6. At the breakwaters of Milwaukee Harbor, the density of coliform organisms showed a very decided increase, but the density of enterococcus was lower than in adjacent areas. Based upon median results the enterococcus-coliform ratio approximated 1 to 700.

7. In the northern portion of Milwaukee County, Wisconsin, low coliform densities were accompanied by a moderately high density of enterococcus organisms. Based upon median results the average enterococcus-coliform ratio approximated 1 to 7.

8. No characteristic enterococcus-coliform ratio existed for the entire section of Lake Michigan waters studied. However, it is apparent from the results secured that the enterococcus determination is a less sensitive measure of bacterial densities of waters than is the coliform determination.

Frequency of Bacteriological Sampling

There are frequently large fluctuations in bacterial densities of samples collected on successive days from the same sample point [illegible] there may be lesser variation in samples taken at different times on the same day. However, on a long series of samples, the extreme variations of a few samples are reduced in significance. Occasional sampling at infrequent intervals may lead to false interpretations. This suggests that the ideal schedule would be daily sampling over the period of investigation. When only a few samples can be processed, daily samples for a short period give more information than infrequent samples over a longer period.

Special Studies

As noted previously, certain objectives of the survey required special studies and analyses of data which were not a part of the routine survey of the lake front waters. These studies included the epidemiological survey of specific population groups adjacent to selected bathing beaches and the possible affect of bathing loads upon the bacterial quality of the beach waters.

The data collected from these studies together with a detailed analysis of the correlation of bacteriological results with physical conditions is being studied and will be presented in later reports. A preliminary review of the data assembled indicates that the effect of the bathing load on the water quality is not significant from the standpoint of fecal contamination in large bodies of natural waters like Lake Michigan. The considerable variations in coliform density sometimes noted over a 12 hour period are evidently due to natural causes, at present unknown.

III - FIELD PROCEDURES

Sanitary Surveys

Sanitary surveys were made of the entire lake shore from the northern limits of Milwaukee County, Wisconsin, to Michigan City, Indiana. These were made by the four cooperating agencies responsible for the survey in the four major areas and were in part a compilation of available data and in part a direct observation of existing conditions at the time of the survey. Particular attention was given to possible sources of sewage pollution including overflows from combined sewer systems, storm drain outlets, industrial waste discharges, unsewered populations near the lake and other potential sources of pollution that might affect the sanitary quality of the shore waters. The results of these surveys in the respective areas are discussed in appended reports A to D under the heading "Sanitary Conditions".

Climatological Data

Efforts were made to assemble all available data on rainfall, wind direction and wind velocity for the period of the survey. Copies of the "Monthly Climatological Summary" were obtained from the Weather Bureau stations in Milwaukee and Chicago. These give daily rainfall measurements for various recording gauge stations in the two areas as well as a daily record of the prevailing direction and average velocity of the wind from recording gauges at the two municipal airports. Non-recording gauges for wind direction and velocity are installed at the sewage treatment plants at Racine and Kenosha, Wisconsin. Arrangements were made to have these gauges read every six hours and the data forwarded regularly to the Public Health Service survey office in Chicago. Recording gauges for wind direction and velocity are in use at Navy Pier and the South District Filtration Plant in Chicago and the data from these gauges were secured. Wind direction is recorded at hourly intervals at the Hammond, Indiana, water filtration plant and these data were secured. In addition to the above, a record of the air temperature and weather condition (fair, rain, etc.) was made each time a sample was collected, noted on the sample card and later copied to the permanent "Master Sheet" record.

Sampling

Beach and shore samples were taken by wading out from shore to just beyond knee depth (approximately two foot water depth) and scooping the sample from about six inches below the surface.

At the time the survey was planned, the question was raised as to whether samples taken in two feet of water would be as representative of conditions as samples taken in four feet of water. To determine this, a series of comparative samples were examined. The results (not presented in this report) indicated that no significant difference was found in the bacterial densities of the comparative samples. In view of this and the desirability of avoiding the use of boats for sample collection, the two foot depth was chosen. In general, sample points on the beaches were located at points of maximum bathing concentration.

Bathing Loads

In order to obtain a record of the bathing load variations at the various beach sampling points without introducing errors due to the human factor, each sample collector was instructed to record on every sample card an actual count of the number of persons in the water on 200 feet of lake front at the sample point. This count was to include all people actually in the water, regardless of the amount of immersion.

Lake Conditions

Each time a sample was taken from the lake waters, the condition of the lake was noted on the sample card under the arbitrary listing of "calm", "rough", or "heavy surf". To eradicate as far as possible any discrepancies due to personal judgment, each sample collector was furnished a written description of the lake condition to which each adjective applied. The temperature of the water at the sample point was taken also and recorded on the sample card.

IV - LABORATORY PROCEDURES

Summary of Routine Laboratory Operations

Up to the end of August, when routine laboratory operations were terminated, a total of approximately 3300 samples had been examined bacteriologically. The routine examination included the determination of the most probable number of coliform organisms (confirmed test) and enterococcus by the Winters and Sandholzer method with minor variations. The pH and turbidity were determined in the laboratory.

In the examination of samples, the general procedures were observed as provided in "Part IV, Bacteriological Examination of Water" in "Standard Methods for the Examination of Water and Sewage (ninth edition) 1946". Details of techniques were agreed upon by the various cooperating agencies. Close cooperation was maintained between laboratories to secure standard technique and procedures. The media were furnished in the dehydrated form and, insofar as possible, the same lot number of each medium was used by all laboratories.

In order to insure uniformity of data from all cooperating laboratories, certain standard forms and methods of reporting laboratory results were developed. A combined sample and laboratory card was devised on which environmental data were entered by the sample collector at the time the sample was collected. Details of the laboratory analytical work were entered on the same card and this card became the permanent record of the cooperating laboratory. The data from the sample card were entered on a "Master Sheet" for each sample point and these master sheets were also retained by the individual laboratory. Each laboratory forwarded all data at regular intervals to the Public Health Service at its laboratory in Chicago, where the results were carefully examined and entered on final record sheets. By this means, and by regular visits to the cooperating laboratories, any discordant results or techniques would have been quickly noted and could have been corrected. It also enabled the Public Health Service, which was charged with coordinating the entire survey, to keep the Advisory Board informed concerning the progress of the project as a whole.

Coliform Test Procedures Used

This procedure is the most delicate and specific bacteriological test for water pollution by sewage under ordinary conditions, as it shows the approximate density of the organisms found in the discharges from the intestinal tracts of warm-blooded animals and less commonly noted from other sources.

The coliform test is made by adding measured decimal portions of the water sample to lactose broth in tubes containing an inverted vial for gas collection. Three tubes of each portion are planted. The tubes are incubated at 35^{0} - 37^{0} C. Tubes having gas in any quantity in 24 or 48 hours are considered presumptive positives for coliform organisms. Those with no gas in 48 hours are discarded as evidence of the absence of lactose fermenting coliform organisms. Presumptive positive lactose tubes are transferred to brilliant-green bile lactose broth. The confirmed positive test for coliform organisms must

show gas production within forty-eight hours when incubated at 35° - 37° C. The most probable number (M.P.N.) of coliform organisms is determined from the number of tubes giving a positive confirmed result with different volumes or dilutions of the original sample. The principle of this method of enumeration is based on the theory of probability that a definite number of coliform bacteria per 100 milliliters is present in the sample tested. The method is subject to considerable error in a single determination. However, a number of samples over a period of time furnishes the most logical and precise method available.

Enterococcus Test Procedures Used

The enterococcus group is comprised of several species of the streptococcus group which have their normal habitat in the intestinal tract of warm-blooded animals. They are characterized as Gram-positive, pleomorphic streptococci, growing in chains. They have in common the ability to ferment dextrose with acid production, grow well at temperatures from 10°C to 45°C and are resistant to 6.5% sodium chloride in the culture medium.

The distribution and significance of the enterococcus group, as an indicator organism of sewage pollution, has not been widely studied. The density of these organisms is many times less than the density of the coliform group in raw sewage, which would indicate that they are less sensitive indicators of traces of sewage pollution.

Decimal portions of three tubes each of the water sample are planted in a presumptive broth medium (Winters and Sandholzer). The tubes are incubated for 12 hours at 45°C. The production of acid (yellow color) and turbidity is presumptive evidence of the presence of enterococcus. No color change proves their absence. Confirmation consists of growth on the slant portion and turbidity in the broth portion (containing penicillin plus 6.5% sodium chloride) of a combination broth-slant confirmatory medium and the demonstration of Gram-positive streptococci on microscopic examination. The most probable number (M.P.N.) is calculated as described for the coliforms.

Enterococcus Studies at Cincinnati, Ohio

In conjunction with the bathing water survey, basic studies of the survival of enterococcus organisms under various conditions were initiated at the Environmental Health Center. These studies are still in progress and it is expected that technical reports will be made on the findings when sufficient data have been accumulated.

On the basis of the work done to date, there is some evidence that high enterococcus results may be indicative of recent sewage pollution.

Appendix A

SURVEY IN WISCONSIN

Prepared
by
Wisconsin Board of Health

CONCLUSIONS

General

The shore waters of the north and south portions of the Wisconsin section are of better quality than in the central section from the Milwaukee water filtration plant to the southern limits of Racine County.

Milwaukee

1. The sanitary quality of the water at the beaches in Milwaukee County north of the water filtration plant are within the limits allowed in many of the standards currently in use for bathing waters. Except for storm drainage from Fox Point and storm overflows from the combined sewer system of Shorewood, only small amounts of pollution enter the lake in this area.

2. Most of the surface drainage from the city of Milwaukee, untreated discharges from storm water relief stations along the intercepting sewers, together with the effluent from the sewage treatment plant serving most of the county, empties into Milwaukee harbor.

3. Due to a normal southerly lake current bordering Wisconsin, the shore waters south of Milwaukee harbor apparently are more affected by pollution from the harbor than are those to the north, and also apparently are affected by local sources of pollution.

Racine

1. The Lombard Avenue and Municipal Beach waters are of an intermediate quality indicating that moderate amounts of pollution are present.

2. The water at the 14th Street Beach is of poor quality. It apparently is affected directly by a shoreline refuse fill and possibly by the sewage treatment plant effluent.

Kenosha

1. The examination of beach water samples indicated that the average quality is relatively satisfactory as compared with other areas studied during the survey.

2. The existence of storm water overflows and the effluent from the sewage treatment plant represent a potential hazard to the bathing areas. At times this is reflected in the quality of water on the beaches.

SAMPLE POINTS

Twenty sample points were established in Milwaukee, Racine and Kenosha counties. Sample points were set on the various public beaches in or near the corporate limits of the three cities, at openings in the breakwaters protecting Milwaukee harbor, in the outlet channel from Kenosha harbor and at the raw water intakes. Due to the fact that all sampling and analytical work was carried on by municipal or county employees in addition to their regular duties, it was not deemed advisable to set extra sample points to determine the condition of the shore waters in the rural areas between the cities. Samples of raw water from the

intakes of the Milwaukee, Racine and Kenosha water plants were taken at frequent intervals by plant personnel.

All sample points were carefully located and described with reference to prominent fixed objects in order that sampling always would be done at the same place and that the same sample points might be used in the future if so desired.

Sampling at Point Racine 5 was not started until July 2. When the sample points were selected in May there was no beach at this point as it had been washed away by the winter storms. By the last of June the lake currents had redeposited enough sand to form a beach which was being used for bathing and a sample point accordingly was set at this location.

The general location of the various sample points are given in Table Wisconsin 1.

TABLE WISCONSIN 1

SAMPLE POINTS

Milwaukee	
1	Fox Point - near Doctors Park
2	Klode Beach
3	Shorewood - Atwater Beach
*R-1	Water Intake
4	Bradford Beach
*5	Opening in north harbor breakwater
*6	West opening in south harbor breakwater
7	South Shore Park Beach
8	Grant Park Beach
Racine	
1	Lombard Avenue
*R-1	Water Intake
2	Municipal Beach - center (High Street)
*3	Municipal Beach - south (north side of harbor jetty)
5	Beach at 14th Street
Kenosha	
1	Alford Park - north end (25th Street)
2	Alford Park - 28th Street
3	Municipal Beach - 50th Street
*R-1	Water Intake
#R-2	Harbor outlet channel
4	Shoreland Park - 78th Street

*Not a shore sample

#Harbor mouth sample

SANITARY CONDITIONS

Milwaukee County

The sanitary sewage from all of Milwaukee County, except Carrollville and South Milwaukee, is discharged into the Milwaukee Metropolitan Sewerage System. The treatment plant for the Metropolitan District is an activated-sludge type plant, located on Jones Island in Milwaukee harbor at the mouth of the Milwaukee, Menomonee and Kinnickinnic Rivers. The treated effluent is discharged into the lake immediately east of the plant.

The Village of Fox Point has separate sanitary and storm sewerage systems, and the Village of Shorewood has a partially combined system with two overflows discharging into Lake Michigan. The City of Milwaukee has a combined system, with the overflows discharging into one of the three rivers, and thence to the lake, except for one outlet in the southern part of the city which discharges directly into Lake Michigan. The City of Cudahy has a combined sewerage system and excess flows discharge into Lake Michigan through two outlets.

The sanitary sewage from the City of South Milwaukee is treated in a primary treatment plant located on the shore of Lake Michigan in the southern portion of the city. The chlorinated effluent is discharged to the lake. The sanitary sewage from the Village of Carrollville is treated in a primary treatment plant and is discharged directly into Lake Michigan. Several industrial plants in this area have treatment works for treating their industrial and sanitary wastes.

Racine County

The area from the Milwaukee County line south to approximately five miles north of the City of Racine is an agricultural area. The sanitary sewage from the populated area north of the City of Racine is discharged directly into Lake Michigan, largely without treatment. The population of this area is approximately 600 persons.

The City of Racine has a combined sewerage system. At times of excess flow the relief sewers discharge either into Lake Michigan or into Root River which flows into Lake Michigan. Normal dry weather flows are treated at the Racine sewage treatment plant, located on the shore of Lake Michigan at the south city limits. Treatment consists of prechlorination, primary settling and postchlorination. The effluent is discharged into the lake approximately 600 feet from shore at a depth of 25 feet.

The sanitary and industrial wastes from the Case South Works are discharged directly into Lake Michigan without treatment. The sanitary sewage from the area south of the corporate limits of the City of Racine, with a population of approximately 1000 people, is discharged directly into the lake.

Kenosha County

The area south of the Racine-Kenosha county line and north of the city limits of Kenosha is fairly well populated. There are approximately 300 homes in this area and probably the majority of these discharge their sewage directly

into Lake Michigan or into farm drainage systems which discharge into the lake.

The City of Kenosha has a combined sanitary and storm sewerage system. At times of excess flow, wastes are discharged either directly into Lake Michigan or into Pike River, which discharges into the lake. During normal flows the wastes are treated in a primary treatment plant located on the shore of Lake Michigan at the southern limits of the city. The effluent is chlorinated and discharged into the lake approximately 1000 feet from shore at a depth of 35 feet.

The area south of the City of Kenosha is sparsely settled at the present time. It is very doubtful whether any sewage from this area is being discharged into the lake, as the soil conditions are favorable for the soil-absorption method of waste disposal.

LABORATORY EXAMINATIONS

During the summer a total of 489 samples were taken from 17 sampling points, exclusive of the raw water intakes, in the Milwaukee, Racine, and Kenosha areas of the Wisconsin shoreline. The most probable number of coliform organisms was determined on all of these samples. On 12 of the 150 samples from the Racine area, the enterococcus MPN was not determined as the necessary media could not be obtained in time. With the exception of the samples from the Kenosha Harbor Channel, all analytical work was done in the Milwaukee County Board of Health, the Racine sewage treatment plant, and the Kenosha (State Cooperative) laboratories.

The samples at Point Kenosha R-2 (entrance channel to Kenosha Harbor) were examined by employees of the Kenosha water filtration plant. Only coliform determinations were made on these samples and these were not carried beyond the presumptive test. The results are presented as an indication of the sanitary quality of the water in this channel.

A total of 266 samples were collected from the three raw water intakes representing deep water lake conditions. Only coliform determinations were made on these samples which were examined in the respective water plant laboratories.

The results are presented in Tables Wisconsin 2 and Wisconsin 3. Much of the same information is shown graphically in Figures Wisconsin 1 and Wisconsin 2.

TABLE WISCONSIN 2

BACTERIOLOGICAL RESULTS

FREQUENCY DISTRIBUTION

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
Milw.										
1	36	25.0	11.1	5.6	0.0	36	55.6	33.3	11.1	2.8
2	36	13.9	5.6	2.8	0.0	36	50.0	36.1	13.9	5.6
3	36	30.6	11.1	0.0	0.0	36	50.0	38.9	8.3	2.8
R-1	122	0.8	-	0.0	0.0	0	-	-	-	-
4	36	55.6	38.9	22.2	2.8	36	44.5	36.1	13.9	0.0
5	36	77.8	66.7	55.6	22.2	36	41.7	33.3	11.1	2.8
6	36	86.1	72.2	66.7	22.2	36	52.8	36.1	11.1	2.8
7	37	75.7	54.0	37.8	16.2	37	62.2	48.7	16.2	0.0
8	37	73.0	54.0	35.1	0.0	37	51.3	46.0	21.6	5.4
Racine										
1	40	47.5	37.5	25.0	5.0	36	0.0	0.0	0.0	0.0
R-1	122	8.4	-	4.1	0.0	0	-	-	-	-
2	40	55.0	47.5	17.5	7.5	36	5.6	0.0	0.0	0.0
3	40	52.5	35.0	22.5	7.5	36	5.6	0.0	0.0	0.0
5	30	93.3	76.7	66.7	20.0	30	10.0	10.0	0.0	0.0
Kenosha										
1	26	23.1	19.2	3.8	No Rec.	26	38.4	23.1	3.8	0.0
2	26	26.9	11.5	7.7	" "	26	38.4	26.9	3.8	0.0
3	25	20.0	8.0	4.0	" "	25	52.0	32.0	8.0	0.0
+R-1	22	0.0	-	0.0	0.0	0	-	-	-	-
+R-2	22	77.5	-	27.3	9.1	0	-	-	-	-
4	26	30.8	11.5	7.7	No Rec.	26	26.9	7.7	3.8	0.0

+Coliform presumptives only

* MPN - Most probable number per 100 ml.

TABLE WISCONSIN 3

BACTERIOLOGICAL RESULTS

DENSITIES

MPN per 100 ml.

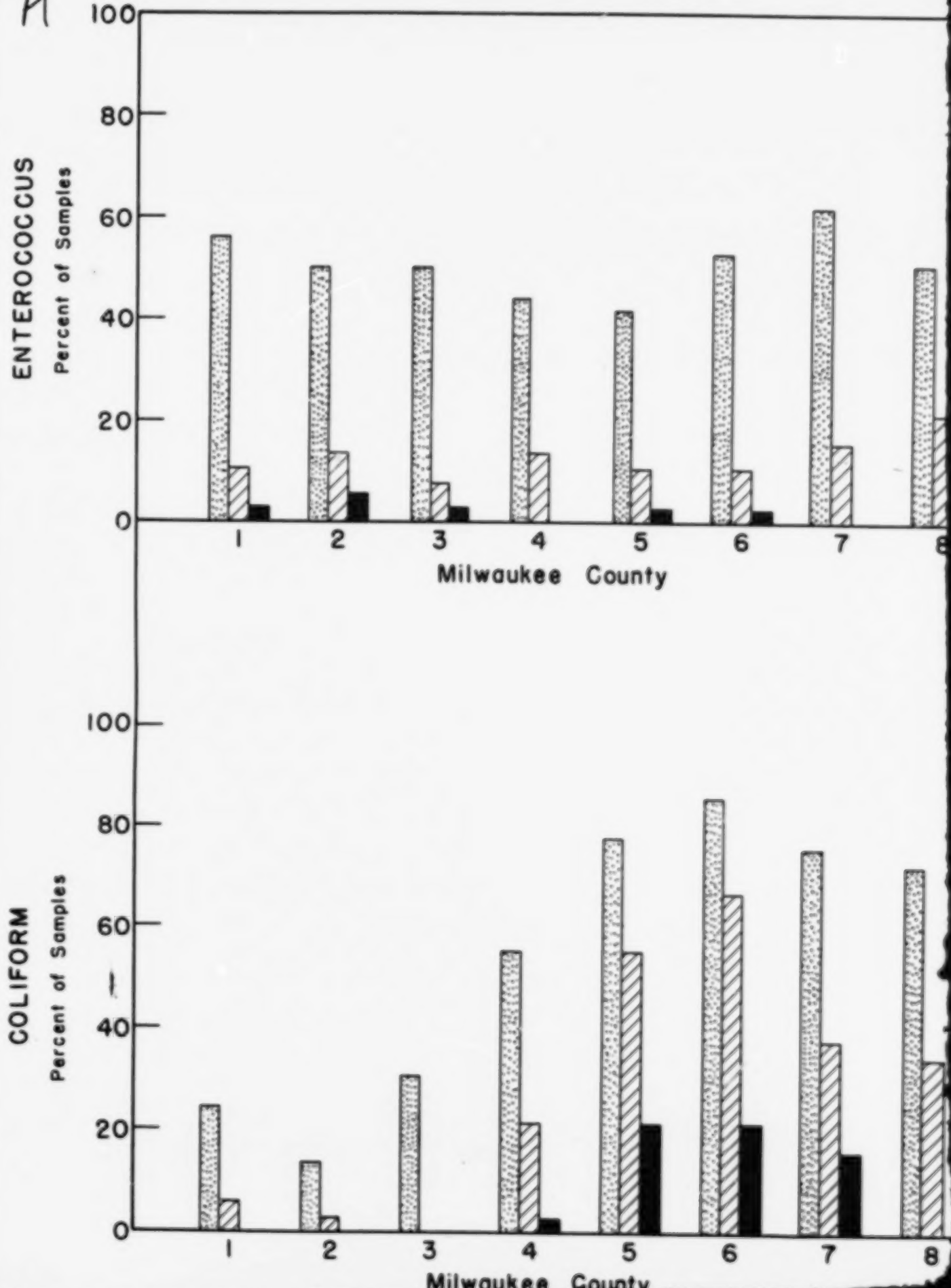
Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
Milwaukee							
1	2,400	-3	43	54	1100	-3	7.3
2	1,400	-3	43	64	460	-3	7.3
3	1,100	-3	93	113	460	-3	9.1
4	24,000	-3	460	344	240	-3	3.6
5	46,000	93	2,400	1,550	460	-3	3.6
6	110,000	91	2,400	2,130	460	-3	7.3
7	11,000	43	930	1,080	240	-3	9.1
8	4,600	3.6	930	655	1100	-3	9.1
Racine							
1	+1,100,000	23	240	468	3.6	-3	-3
2	+1,100,000	23	430	515	9.1	-3	-3
3	43,000	9.1	315	435	9.1	-3	-3
5	+1,100,000	43	2,400	3,200	43	-3	-3
Kenosha							
1	+1,100	-3	68	71	93	-3	3.6
2	+1,100	-3	68	76	240	-3	3.3
3	+1,100	3.6	150	113	93	-3	6.3
*B-2	11,000	43	610	645	-	-	-
4	2,400	-3	93	100	75	-3	3.6

*Presumptives only

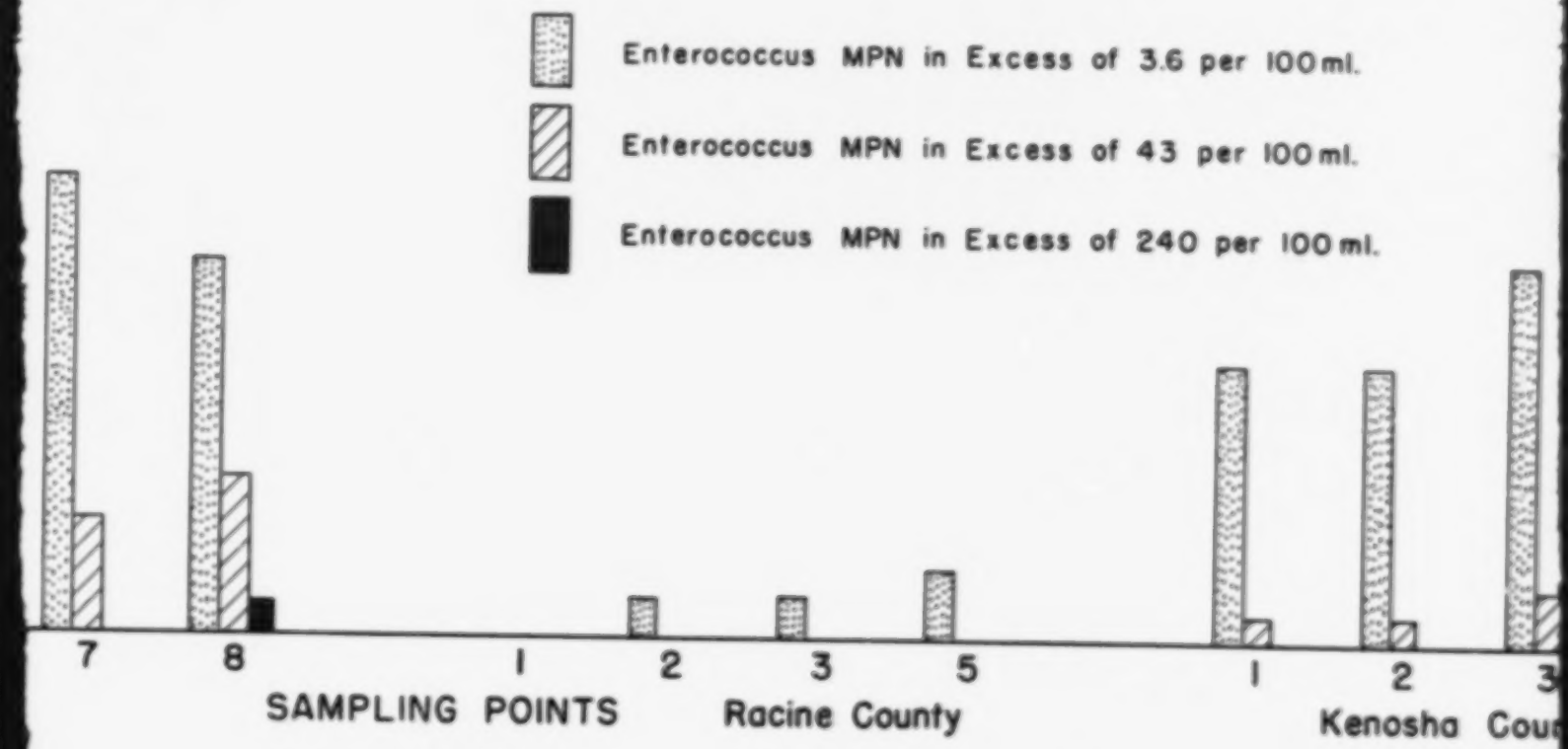
- indicates MPN indeterminate, but less than figure given

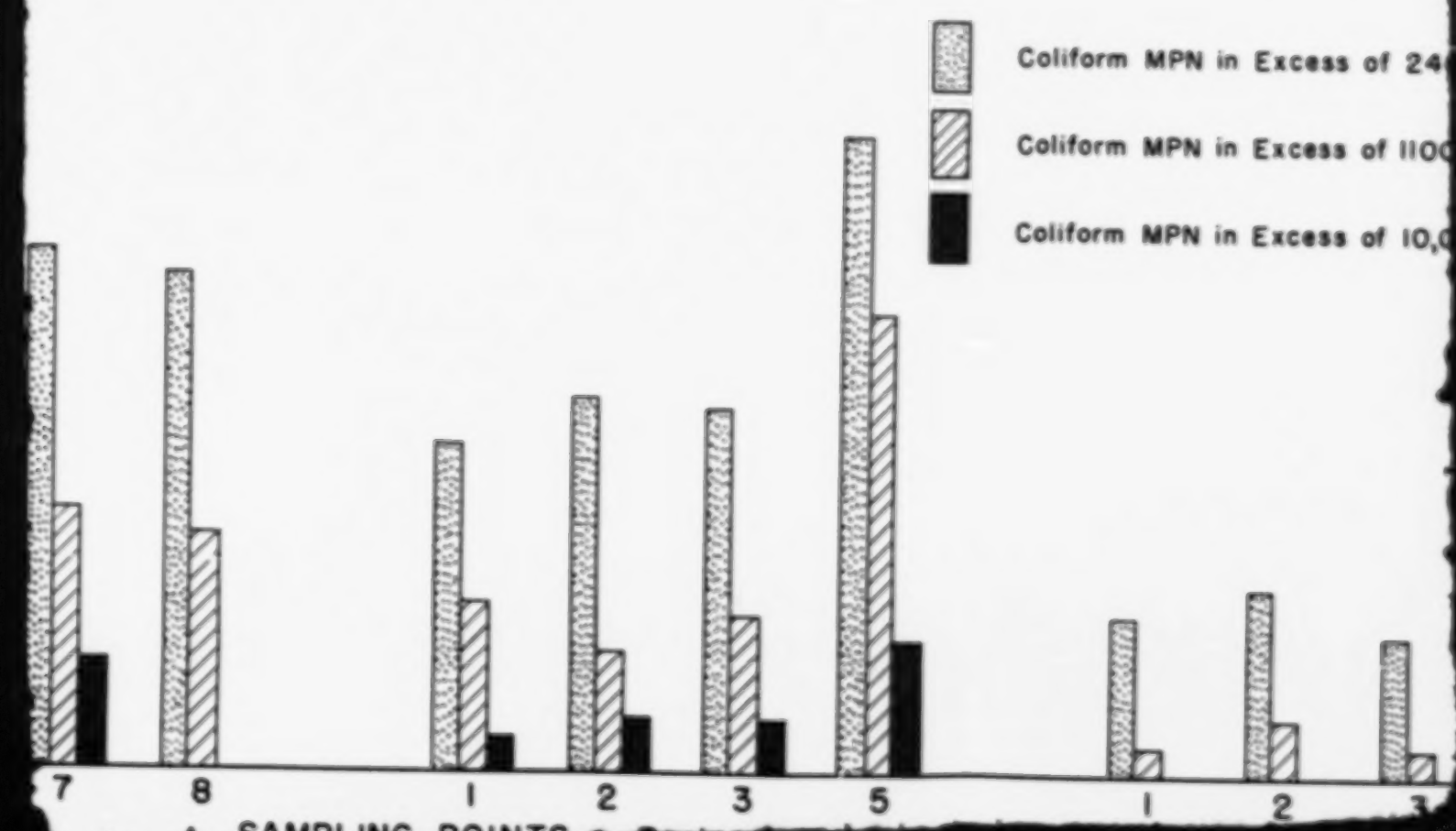
+ indicates MPN indeterminate, but greater than figure given

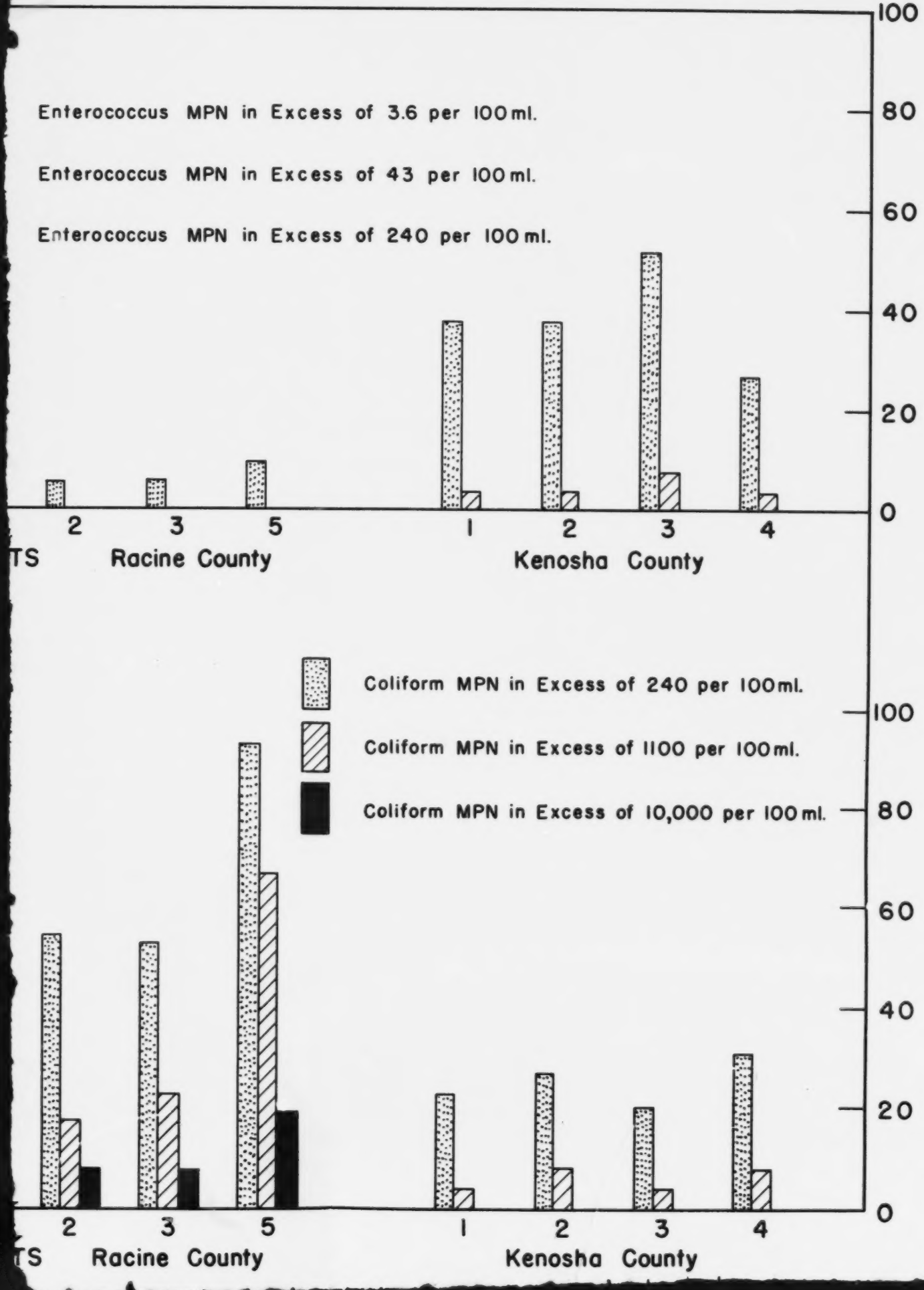
A

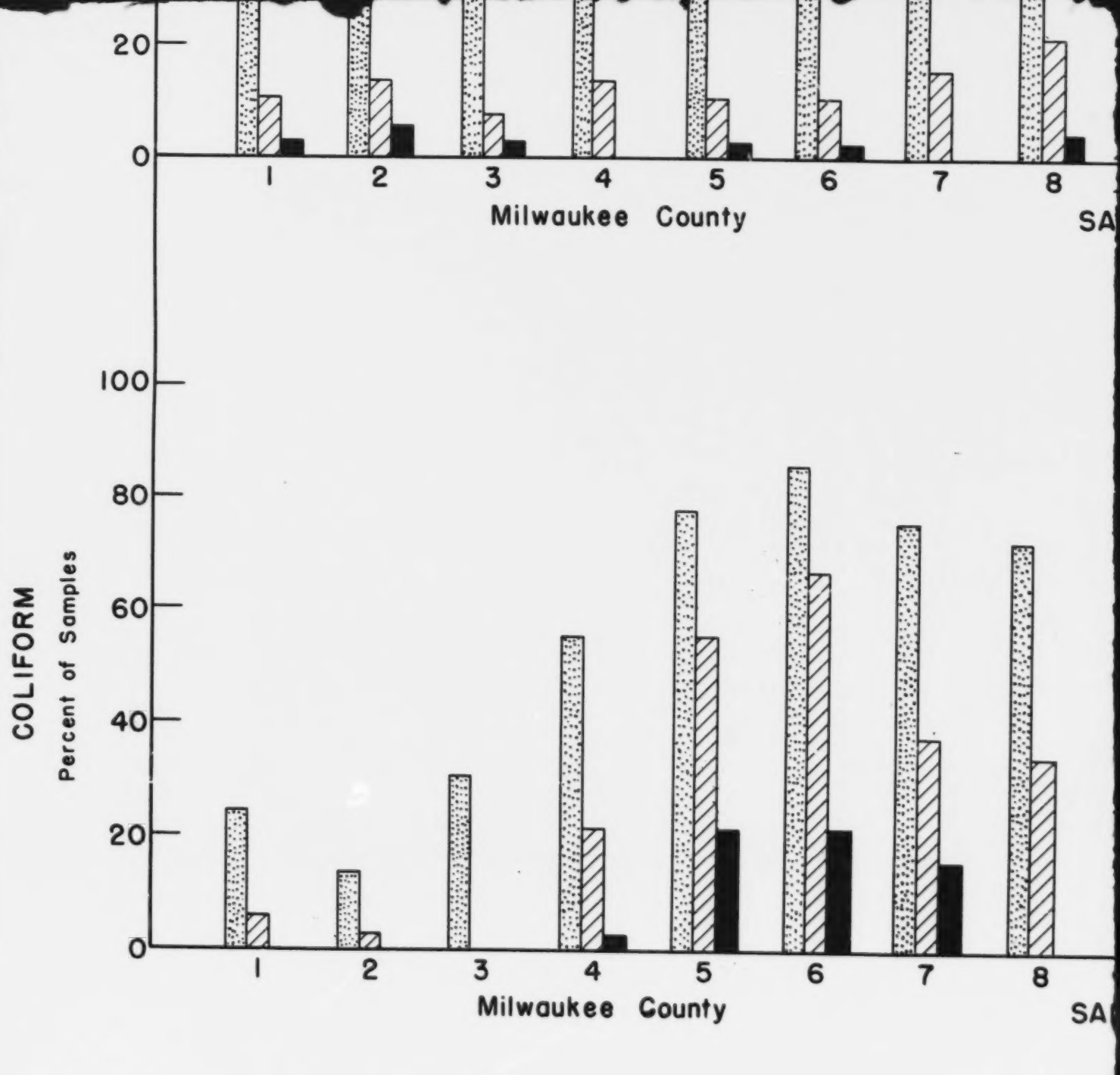

ENTEROCOCCUS
Percent of Samples
100
80
60
40
20
0
1
2
3
4
5
6
7
8
Milwaukee County
COLIFORM
Percent of Samples
100
80
60
40
20
0
1
2
3
4
5
6
7
8
Milwaukee County

B


Enterococcus MPN in Excess of 3.6 per 100 ml.
Enterococcus MPN in Excess of 43 per 100 ml.
Enterococcus MPN in Excess of 240 per 100 ml.
7
8
1
2
3
5
1
2
3
SAMPLING POINTS
Racine County
Kenosha Cou


Coliform MPN in Excess of 24
Coliform MPN in Excess of 110
Coliform MPN in Excess of 10,
7
8
1
2
3
5
1
2
3
SAMPLING POINTS


Enterococcus MPN in Excess of 3.6 per 100 ml.
Enterococcus MPN in Excess of 43 per 100 ml.
Enterococcus MPN in Excess of 240 per 100 ml.
100
80
60
40
20
0
2
3
5
1
2
3
4
TS
Racine County
Kenosha County
Coliform MPN in Excess of 240 per 100 ml.
Coliform MPN in Excess of 1100 per 100 ml.
Coliform MPN in Excess of 10,000 per 100 ml.
100
80
60
40
20
0
2
3
5
1
2
3
4
TS
Racine County
Kenosha County


20
0
1
2
3
4
5
6
7
8
Milwaukee County
SA
100
80
60
40
20
0
COLIFORM
Percent of Samples
1
2
3
4
5
6
7
8
Milwaukee County
SA

D

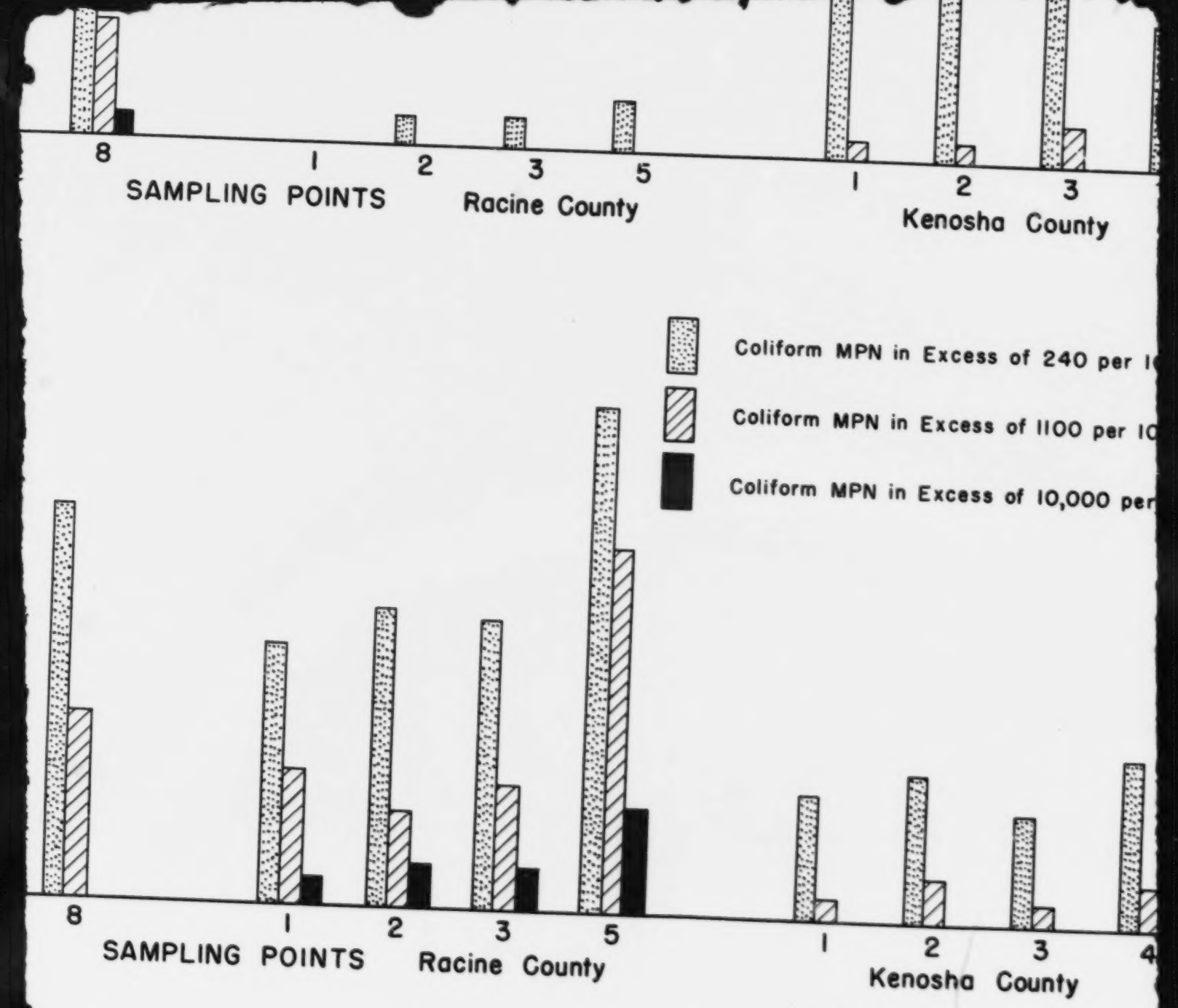


FIG. WISCONSIN 1

Tri-State Survey of Lake Michigan
Relation of Coliform & Enteroco

Wisconsin

June-July-August

U.S.P.H.S.
Cincinnati, Ohio

Environmental Health
December

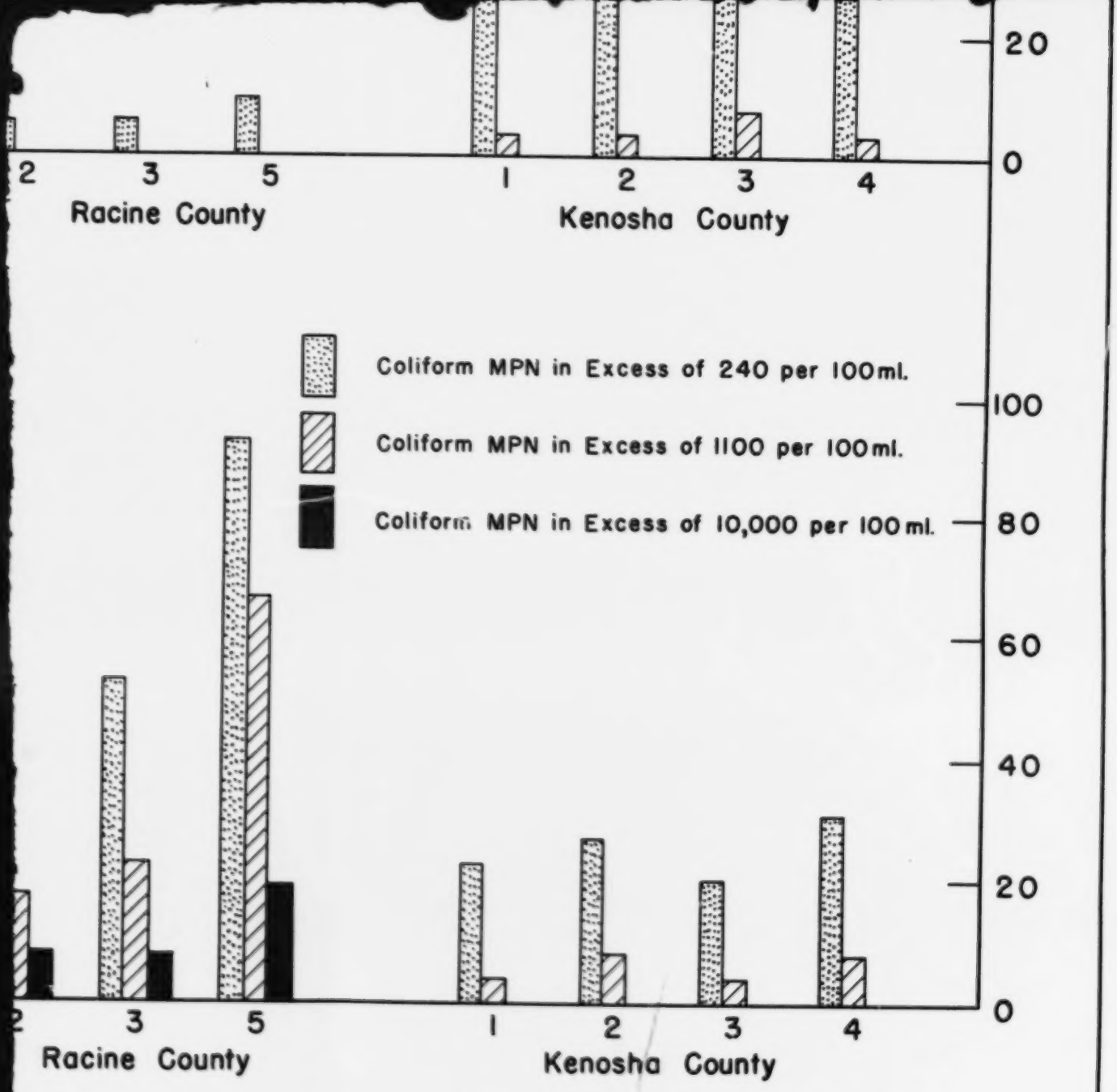


FIG. WISCONSIN 1

Tri-State Survey of Lake Michigan Waters
Relation of Coliform & Enterococcus

Wisconsin

June-July-August

U.S.P.H.S.
Cincinnati, Ohio

Environmental Health Center
December 1948

F

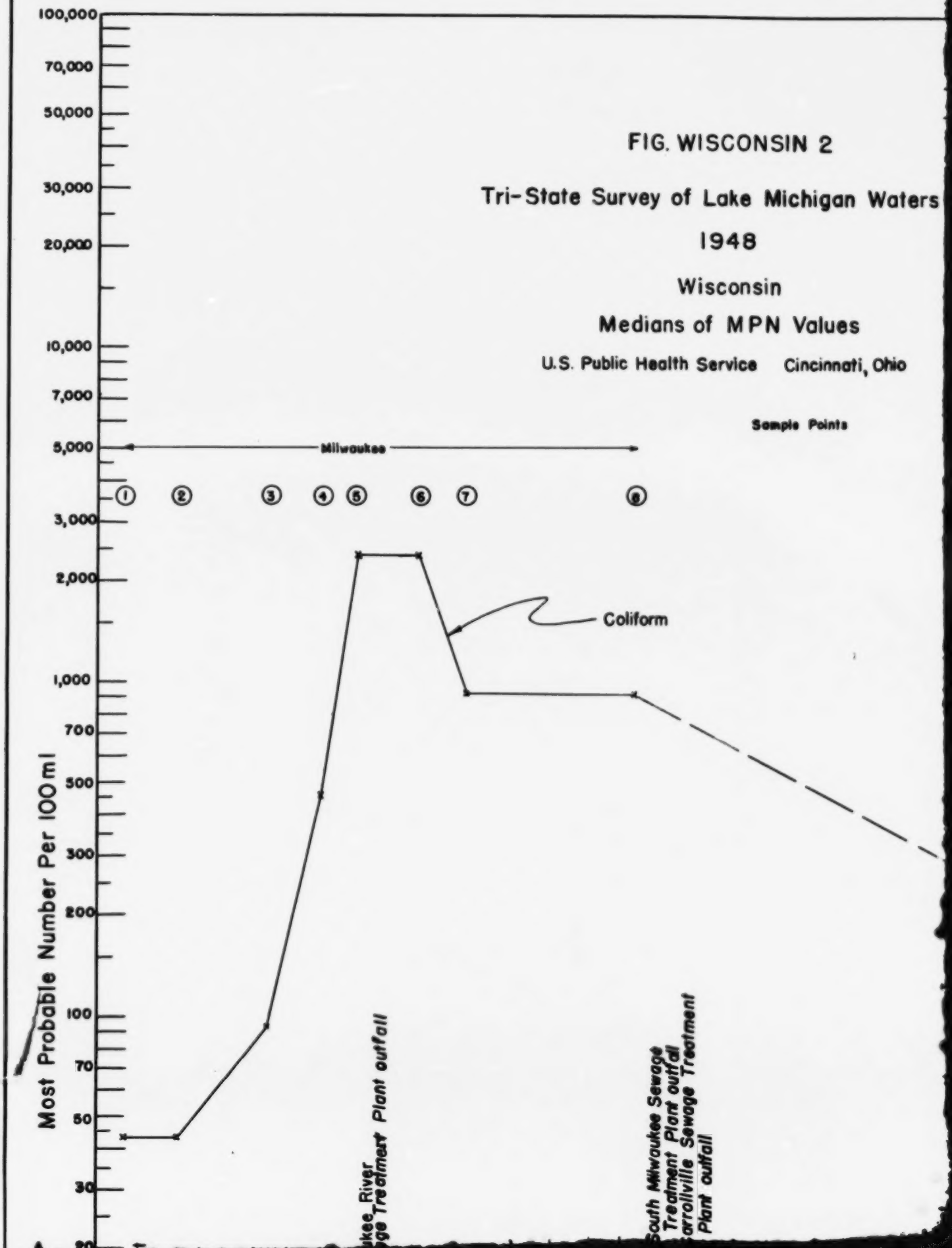


FIG. WISCONSIN 2
Tri-State Survey of Lake Michigan Waters
1948
Wisconsin
Medians of MPN Values
U.S. Public Health Service Cincinnati, Ohio
Sample Points
Milwaukee
1
2
3
4
5
6
7
8
Coliform
Most Probable Number Per 100 ml
100,000
70,000
50,000
30,000
20,000
10,000
7,000
5,000
3,000
2,000
1,000
700
500
300
200
100
70
50
30
South Milwaukee Sewage Treatment Plant outfall
Carrollville Sewage Treatment Plant outfall

SCONSIN 2

Lake Michigan Waters

948

consin

MPN Values

rvice Cincinnati, Ohio

Sample Points

←Racine→ ←Kenosha→

① ②③ ⑤ ⑫ ⑬ ④

100,000
70,000
50,000
30,000
20,000
10,000
7,000
5,000
3,000
2,000
1,000
700
500
300
200
100
70
50
30

Most Probable Number Per 100 ml

d Point

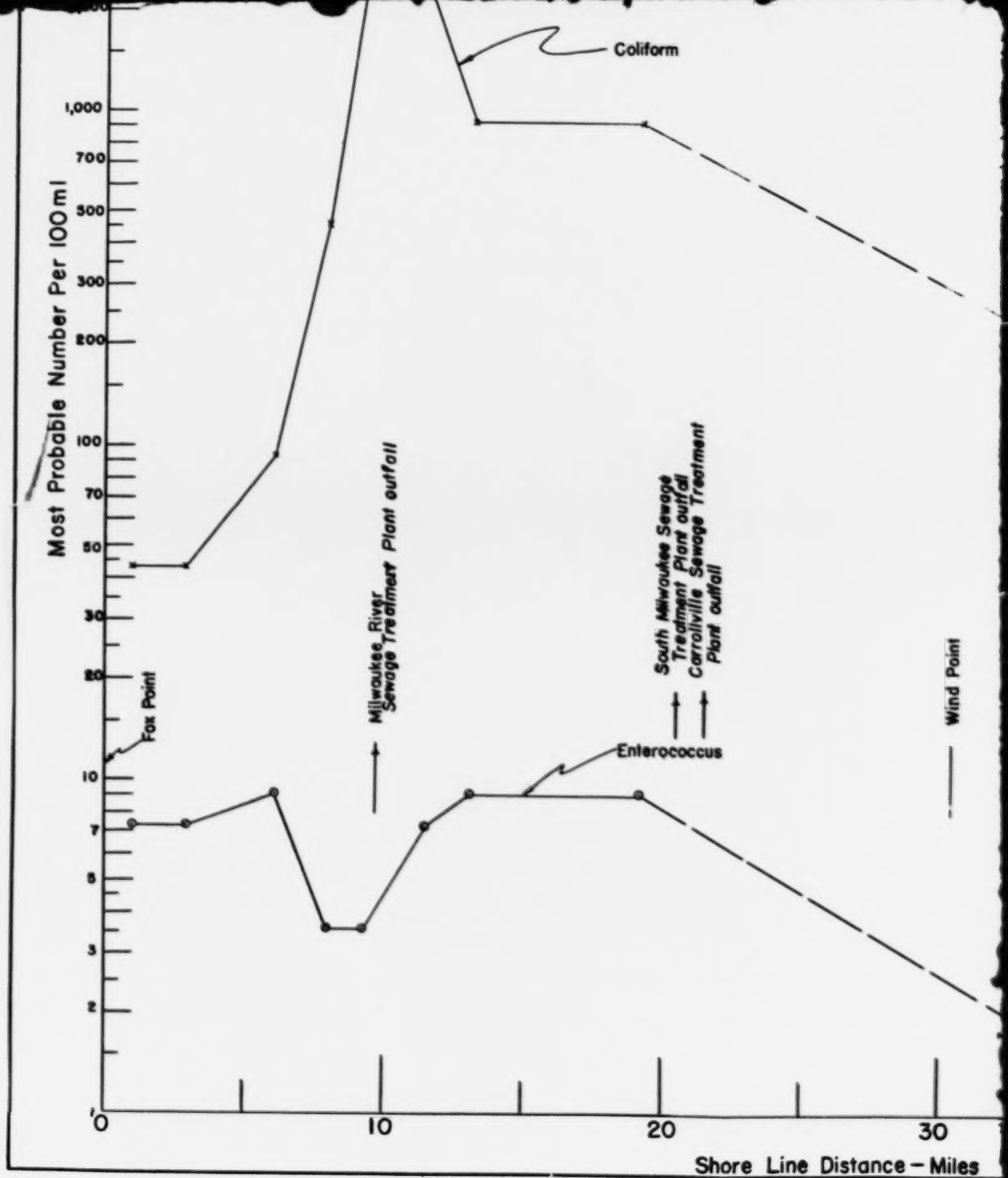
t River

ne Sewage Treatment
nt outfall

ha Harbor
River)

sha Sewage Treatment
t outfall

nsin-Illinois State Line


Most Probable Number Per 100 ml
1,000
700
500
300
200
100
70
50
30
20
10
7
5
3
2
1
Coliform
Enterococcus
Fox Point
Milwaukee River Sewage Treatment Plant outfall
South Milwaukee Sewage Treatment Plant outfall
Carrollville Sewage Treatment Plant outfall
Wind Point
0
10
20
30
Shore Line Distance – Miles

C

Most Probable Number Per 100 ml

2,000
1,000
700
500
300
200
100
70
50
30
20
10
7
5
3
2

Wind Point
Root River
Racine Sewage Treatment Plant outfall
Kenosha Harbor (Pike River)
Kenosha Sewage Treatment Plant outfall
Wisconsin–Illinois State Line

MPH less than 3.0

30
40
50

Shore Line Distance – Miles

DISCUSSION

The laboratory results confirm the observation that Milwaukee harbor is the major focal point of pollution along the lake shore in Milwaukee County. The shore waters to the north of the harbor tend to improve in quality on the basis of the coliform test, and, north of the water filtration plant, show the most satisfactory results obtained in the Wisconsin portion of the study. The normal southerly lake current in this area undoubtedly assists in this improvement.

The beach waters south of the harbor are relatively poor in quality which may be aggravated by additional sources of pollution from combined sewer overflows, sewage and industrial waste treatment plant effluents, and a yacht basin just south of the main harbor. The enterococcus results on the other hand appear to be relatively constant for all eight sampling points on the basis of the frequency distribution shown in Table Wisconsin 2.

The laboratory results on the coliform test reflect that pollution, from the several sources noted, at times affects the Lombard Avenue and Municipal Beaches in Racine. On occasion extremely high densities in excess of 1,100,000 per 100 ml. have been observed. However, the average water quality appears to be in an intermediate group as compared with other areas under survey.

The beach at 14th Street, Racine, is located approximately 0.6 mile south of a shore area being used as a refuse fill, and about one mile north of the sewage treatment plant outfall. Laboratory results confirm that extensive pollution is reaching the beach from one or both of these sources. Proximity and the normal southerly lake current would tend to incriminate the fill area. It is interesting to note that at all Racine sampling points the enterococcus density was extremely low.

Laboratory results indicate that the four shore points sampled in Kenosha County were among the best areas in the survey from the standpoint of the coliform test. However, it is noted that sources of pollution do exist in the form of septic tank effluents, combined sewer storm overflows, and a sewage treatment plant effluent located south of the most southerly sample point. The enterococcus results as shown by the frequency distribution varied somewhat. The results for Municipal Beach at 50th Street appeared to be quite high, similar to those observed for Milwaukee harbor and vicinity.

Appendix B

SURVEY IN ILLINOIS (LAKE COUNTY)

Prepared
by
Illinois Sanitary Water Board

CONCLUSIONS

1. Apparently pollution did not constitute a hazard to the safety of the public water supplies.

2. In the vicinity of North Chicago and Great Lakes Naval Training Center considerable pollution in the form of untreated sewage and industrial waste was found in the creeks and in the lake. It was sufficient to constitute a potential hazard to those using these waters for bathing purposes.

3. The sewage treatment plant at Great Lakes Naval Center and the plants of the North Shore Sanitary District generally produced effluents of satisfactory coliform densities. All plants, however, on occasion, produced effluents having high coliform densities. The frequency of these occasions was greatest at the North Chicago plant, and somewhat less so at the Zion plant, where chlorination was not started until the first week in July.

4. Camp Logan did not contribute significant sewage pollution to the lake waters.

5. Wastes discharge into Pettibone Creek from sewers within Great Lakes Naval Training Center and from several North Chicago industries and contribute to the pollution of Lake Michigan.

6. Storm flows, private septic tank effluents, and seepage from faulty sewers discharged into the ravines in Highland Park, Lake Forest, Lake Bluff, North Chicago, Waukegan, Zion and Winthrop Harbor constituted a potential pollutional hazard.

7. Wastes contributing to bacterial pollution were discharged into Lake Michigan from a number of industries.

SAMPLE POINTS

A total of 37 routine sampling points were established along the 25 mile Lake County water front. These were set on all organized or commonly used beaches open to the public, certain intermediate shore points of importance, and at a few other points where it was believed that pollution might be entering the lake in significant quantities. All sample points were carefully located and nearly all were described in reference to prominent fixed objects in order that sampling would always be done at the same place and that the same sample points might be used in the future should occasion require. During the period from June 6 to August 29, each of these points was sampled from 20 to 48 times by State personnel. All points with the exception of 1, 13, and 36 were sampled on at least 42 different occasions.

In addition to these routine sample points, raw water samples were collected at frequent intervals from the raw water intakes at Waukegan, North Chicago, Great Lakes Naval Training Center, and Lake Forest by plant personnel. Samples were not taken from the intakes of the Highwood and Highland Park plants.

Samples were also collected at frequent intervals from the effluents of the

various sewage treatment plants of the North Shore Sanitary District by employees of the Sanitary District. Coliform density determinations were made on these samples in laboratories of the North Shore Sanitary District.

The general locations of the various sample points are given in Table Lake 1.

TABLE LAKE 1

SAMPLE POINTS

37	Winthrop Harbor. Bathing beach at state line
• 40	Winthrop Harbor. Sewage treatment plant effluent
36	Camp Logan. Beach at north limits
35	Zion. Rosea Beach (25th Street)
• 41	Zion. Sewage treatment plant effluent
34	Zion. Lake at 29th Road
33	Illinois State Beach Park. Bathing beach
1	Waukegan. Lake shore at Greenwood Road
• 2	Waukegan. Sewage treatment plant effluent
3	Waukegan. Lake shore north of water works
4	Waukegan. Water Works Bathing Beach
•R-1	Waukegan. Raw water intake
5	Waukegan. Lake shore at Water Street
6	North Chicago. Lake shore north of American Steel and Wire plant
7	North Chicago. Lake shore south of American Steel and Wire plant
• 8	North Chicago. Sewage treatment plant effluent
9	North Chicago. Lake at Sunderland Creek (Abbott Ravine)
10	North Chicago. Foss Park Bathing Beach
•R-2	North Chicago. Raw water intake
11	Great Lakes. Bathing beach, north end
12	Great Lakes. Bathing beach, south end
•R-3	Great Lakes. Raw water intake
• 15	Great Lakes. Pettibone Creek
• 13	Great Lakes. Outer end south breakwater
• 14	Great Lakes. Sewage treatment plant effluent at outfall on south breakwater
31	Lake Bluff. Arden Shores Camp beach
16	Lake Bluff. Municipal bathing beach
• 17	Lake Bluff. Sewage treatment plant effluent
•R-4	Lake Bluff. Raw water intake
18	Lake Forest. Park bathing beach at Deerpath Road
• 19	Lake Forest. Sewage treatment plant effluent
20	Fort Sheridan. Officers bathing beach
22	Highland Park. Beach north of Moraine Hotel
23	Highland Park. Park Avenue boat basin
24	Highland Park. Central Avenue Bathing Beach
• 25	Highland Park. Park Avenue sewage treatment plant effluent
• 28	Highland Park. Ravine Drive sewage treatment plant effluent
27	Highland Park. Ravine Drive Bathing Beach
• 30	Highland Park. Cary Avenue sewage treatment plant effluent
29	Highland Park. Roger Williams Bathing Beach

• Not a shore sample

SANITARY CONDITIONS

Sanitary Sewage

With the exception of about six square miles, the entire area in Lake County that drains to Lake Michigan is included in the North Shore Sanitary District. As the municipalities form a nearly continuous chain from Highland Park on the south to Winthrop Harbor on the north, nearly all sewage is intercepted and is treated by the North Shore Sanitary District sewage treatment works located on the lake shore. Other treatment works of the District are located on Skokie River, which is tributary to the North Branch of the Chicago River and eventually to the Illinois River.

Although both combined and separate systems of sewers are included in the municipalities, all sewer systems have overflows which discharge to Lake Michigan. In addition, there are some instances of surcharge at manholes on those sewers which are laid in ravines, although overflows from these are infrequent during the summer months. Much storm water run-off is discharged to the lake through natural watercourses.

The seven municipalities are served by nine sewage treatment plants of the North Shore Sanitary District, all using primary sedimentation and effluent chlorination. Waukegan, in addition, uses chemical precipitation to aid sedimentation. The plants at Winthrop Harbor, Waukegan, Lake Bluff, Lake Forest, Park Avenue, Ravine Drive, and Cary Avenue, produced reasonably satisfactory effluents, except in the infrequent instances when an adequate chlorine residual was not maintained. The plant at Zion did not start effluent chlorination until the first week in July; it produced a reasonably satisfactory effluent after that date.

At the North Chicago plant, where strong industrial wastes from pharmaceutical manufacturing interfered with chlorination, the effluents frequently contained high coliform densities. The lack of a chlorine contact tank at the Cary Avenue plant makes control of chlorination more difficult and presents a potential hazard to adjacent bathing areas.

The two large military establishments, located at Fort Sheridan and at Great Lakes, have sewer systems and complete sewage treatment by means of primary sedimentation, trickling filters and chlorination of effluent. At Great Lakes Naval Training Center two important sewers from the Camp Downes and Camp Porter areas discharging into Pettibone Creek were discovered late in the summer of 1948. Several minor sources on the main post also discharge to this creek, but these have been partially corrected. Camp Logan, a National Guard establishment at Zion, is operated primarily during weekends. It is served by septic tanks and temporary chlorination facilities with the effluents discharged to Kellogg Ditch. This ditch was not flowing to the lake continuously during the summer. Pollution has been serious in previous years and a new treatment plant is being designed.

All plants, both municipal and military, receive adequate maintenance and technical control.

Fifty-four outlets, generally septic tank or subsurface seepage discharges, from private residences or institutions enter ravines draining to the lake. A relatively few outlets from private residences and one camp are scattered along the lake front.

Industrial Wastes

Industrial wastes entering the lake are primarily confined to the area from North Chicago to Waukegan, although small amounts are included in the sewage at Zion.

At North Chicago, the wastes originate from pharmaceutical and metal processing industries. Some of these industries have outlets to Pettibone Creek which flows into the harbor at Great Lakes Naval Training Center. Other outlets discharge to Sunderland Creek (Abbott Ravine) which enters the lake north of the Naval Training Center. There are other outlets discharging directly into the lake from industries in North Chicago and Waukegan. Despite heavy application of chlorine, the pharmaceutical wastes, which discharge to Sunderland Creek, were extremely high in coliform content.

At Waukegan there are many potential sources of industrial wastes, including coke and chemical production, tanneries, asbestos processing and metal processing. Discharge of these wastes is reasonably well controlled and they did not reach the lake in significant pollutional amounts during this survey.

Ravines

There are thirty-nine ravines along the Lake County shoreline and seventeen were observed to have small flows to the lake. Six of the ravines were considered as moderate sources of pollution and two (Pettibone and Sunderland Creeks in the Great Lakes-North Chicago area) as major sources. The outlets carrying pollution to the ravines totaled ninety-five, fifty-four of which were from private residences or institutions and were generally septic tank or subsurface seepage discharges. Thirty-four were from municipal sources, such as storm drains with illicit sewage connections, or leaks and breaks in municipal sewers. The majority of the ravines were blocked by sand at the beaches and such flow as reached these barriers was ponded and filtered through the beach sand.

The pollution of ravines created a nuisance local in character with the exception of industrial discharges to Sunderland and Pettibone Creeks, but during times of rainfall, accumulated material was undoubtedly washed into the lake from many of the ravines.

LABORATORY EXAMINATIONS

During the summer a total of 1005 samples were collected from the 27 regular sampling points in the area. Coliform and enterococcus determinations were made on each sample at the Great Lakes Naval Training Center laboratory by personnel of the Illinois Sanitary Water Board.

In addition, 168 samples from the four raw water intakes at Waukegan, North Chicago, Great Lakes Naval Training Center and Lake Forest were examined for

coliform content at the respective plant laboratories. There were 291 samples collected from the chlorinated effluents of the various sewage treatment plants of the North Shore Sanitary District. These were examined for coliform content in its laboratories.

The results are presented in Tables Lake 2 and Lake 3. Much of the same information is shown graphically in Figures Lake 1 and Lake 2.

TABLE LAKE 2

BACTERIOLOGICAL RESULTS

FREQUENCY DISTRIBUTION

June 23 - August 31

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
WINTHROP HARBOR										
37	42	38.1	31.0	23.8	0.0	42	16.7	9.5	2.4	0.0
40(S)	24	29.2	29.2	20.8	16.7	0	-	-	-	-
CAMP LOGAN										
36	39	25.7	20.5	12.8	2.6	39	5.1	2.6	0.0	0.0
ZION										
35	43	46.5	34.9	25.6	9.3	43	70.9	14.0	0.0	0.0
●41(S)	26	19.2	19.2	19.2	15.4	0	-	-	-	-
34	43	48.8	39.5	18.6	11.6	43	25.6	16.3	9.3	2.3
ILLINOIS STATE BEACH PARK										
33	43	34.9	30.2	11.6	2.3	43	11.6	7.0	0.0	0.0
WAUKEGAN										
1	20	55.0	35.0	20.0	0.0	20	30.0	15.0	10.0	0.0
2(S)	34	23.5	14.7	8.8	2.9	0	-	-	-	-
3	42	50.0	42.9	31.0	7.1	42	28.6	19.1	7.1	7.1
4	42	45.3	23.8	14.3	4.8	42	9.5	4.8	0.0	0.0
R-1	55	7.3	5.5	0.0	0.0	0	-	-	-	-
5	42	69.0	50.0	42.9	9.5	42	31.0	16.7	11.9	2.4
NORTH CHICAGO										
6	42	76.2	73.9	64.3	7.1	42	40.5	33.4	9.5	2.4
7	44	88.7	72.7	63.6	25.0	44	29.5	22.7	9.1	2.3
8(S)	35	68.5	60.0	45.7	2.9	0	-	-	-	-
9	48	91.7	83.3	81.3	68.7	48	62.5	58.3	45.8	33.3
10	44	66.0	59.1	54.5	25.0	44	27.3	13.6	9.1	4.5
R-2	48	12.5	10.4	8.3	0.0	0	-	-	-	-
GREAT LAKES NAVAL TRAINING CENTER										
11	48	62.5	54.2	43.8	25.0	48	20.8	12.5	6.3	4.2
12	47	57.5	38.3	29.8	14.9	47	21.3	14.9	8.5	4.3
R-3	37	0.0	0.0	0.0	0.0	0	-	-	-	-
15	48	95.9	95.9	93.7	75.0	48	85.4	85.4	81.2	58.3
13	26	50.0	38.4	30.8	7.7	26	19.2	7.7	3.8	3.8
14(S)	46	37.0	26.1	10.9	4.4	46	63.0	56.5	39.1	19.6
LAKE BLUFF										
31	43	58.1	44.2	25.6	4.7	43	20.9	14.0	4.7	0.0
16	44	52.3	31.8	25.0	6.8	44	20.5	15.9	6.8	4.5
17(S)	26	19.2	19.2	11.5	3.8	0	-	-	-	-
R-4	28	0.0	0.0	0.0	0.0	0	-	-	-	-

(cont'd)

Table Lake 2 (cont'd)

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
				LAKE FOREST						
18	44	34.1	20.5	15.9	2.3	44	11.4	6.8	0.0	0.0
19(S)	27	29.6	18.5	11.1	3.7	0	-	-	-	-
				FORT SHERIDAN						
20	44	34.1	20.4	11.4	2.3	44	20.4	4.5	0.0	0.0
				HIGHLAND PARK						
22	44	45.5	36.4	27.3	11.4	44	13.6	11.4	4.5	0.0
23	44	18.2	13.6	6.8	2.3	44	15.9	6.8	0.0	0.0
24	44	27.2	20.5	13.6	4.6	44	11.4	0.0	0.0	0.0
25(S)	26	15.4	7.7	7.7	7.7	0	-	-	-	-
28(S)	27	3.7	3.7	0.0	0.0	0	-	-	-	-
27	44	31.8	29.6	25.0	0.0	44	13.6	4.6	0.0	0.0
30(S)	20	35.0	25.0	15.0	10.0	0	-	-	-	-
29	44	43.2	31.8	25.0	4.5	44	9.1	2.3	0.0	0.0

*MPN - Most probable number per 100 ml
(S) - Sewage treatment plant effluent (chlorinated)
R- - Water plant intake
● - Effluent chlorination started about July 5

TABLE LAKE 3

BACTERIOLOGICAL RESULTS

DENSITIES

MPN per 100 ml.
June 23 - August 31

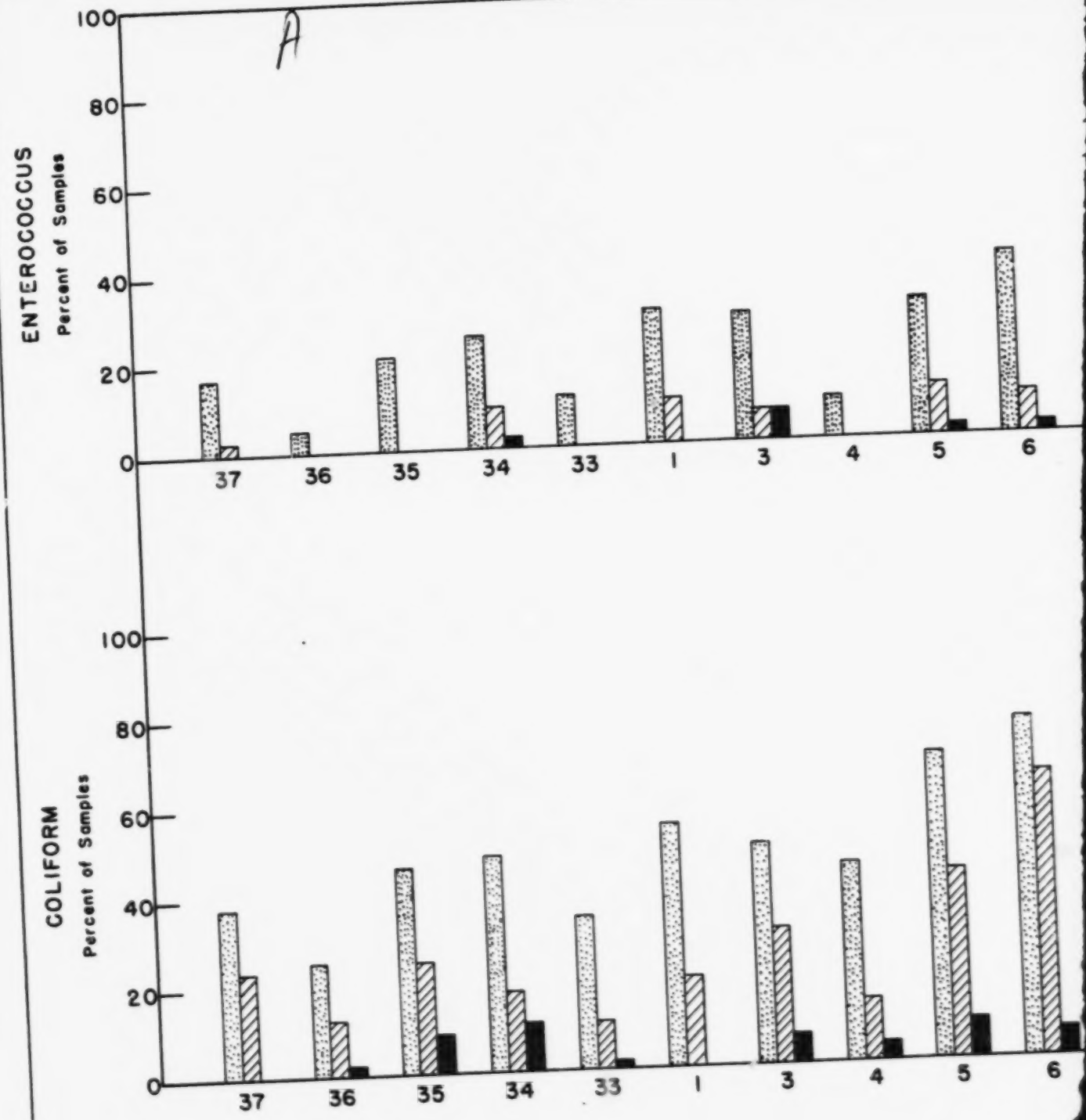
Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
			WINTHROP HARBOR				
37	9300	3.6	150	198	93	-3	-3
40(S)	+110,000	-30	133	215	—	—	—
			CAMP LOGAN				
36	+110,000	23	91	145	9.1	-3	-3
			ZION				
35	46,000	3.6	230	276	93	-3	-3
41(S)	11,000,000	-30	-30	147	—	—	—
34	110,000	-3	240	337	1100	-3	-3
			ILLINOIS BEACH STATE PARK				
33	21,000	7.3	91	131	43	-3	-3
			WAUKEGAN				
* 1	4,300	30	355	311	240	-3	3.3
2(S)	11,000	-30	82	115	—	—	—
3	46,000	-3	265	369	+1100	-3	-3
4	+110,000	15	240	263	9.1	-3	-3
R-1	1,100	-3	43	46	—	—	—
5	+110,000	-30	682	958	+1100	-3	-3
			NORTH CHICAGO				
6	15,000	43	2400	1540	460	-3	3.6
7	+110,000	-3	2400	2650	460	-3	-3
8(S)	11,000	-30	930	550	—	—	—
9	110,000,000	-30	195,000	88,500	460,000	-3	41
10	120,000	21	2400	1420	+11,000	-3	-3
R-2	9,300	-3	22	46	—	—	—
			GREAT LAKES NAVAL TRAINING CENTER				
11	+110,000	7.3	840	1030	1100	-3	-3
12	+110,000	23	430	542	1100	-3	-3
R-3	240	-3	9.1	8.7	—	—	—
15	110,000,000	-3	44,500	49,900	110,000	-3	460
13	110,000	-3	300	413	460	-3	-3
14(S)	+110,000	3.6	92	157	+11,000	-3	23
			LAKE BLUFF				
31	110,000	23	430	544	240	-3	-3
16	+110,000	9.1	360	328	+1100	-3	3.0
17(S)	11,000	-30	36	84	—	—	—
R-4	240	-3	-3	—	—	—	—

(cont'd)

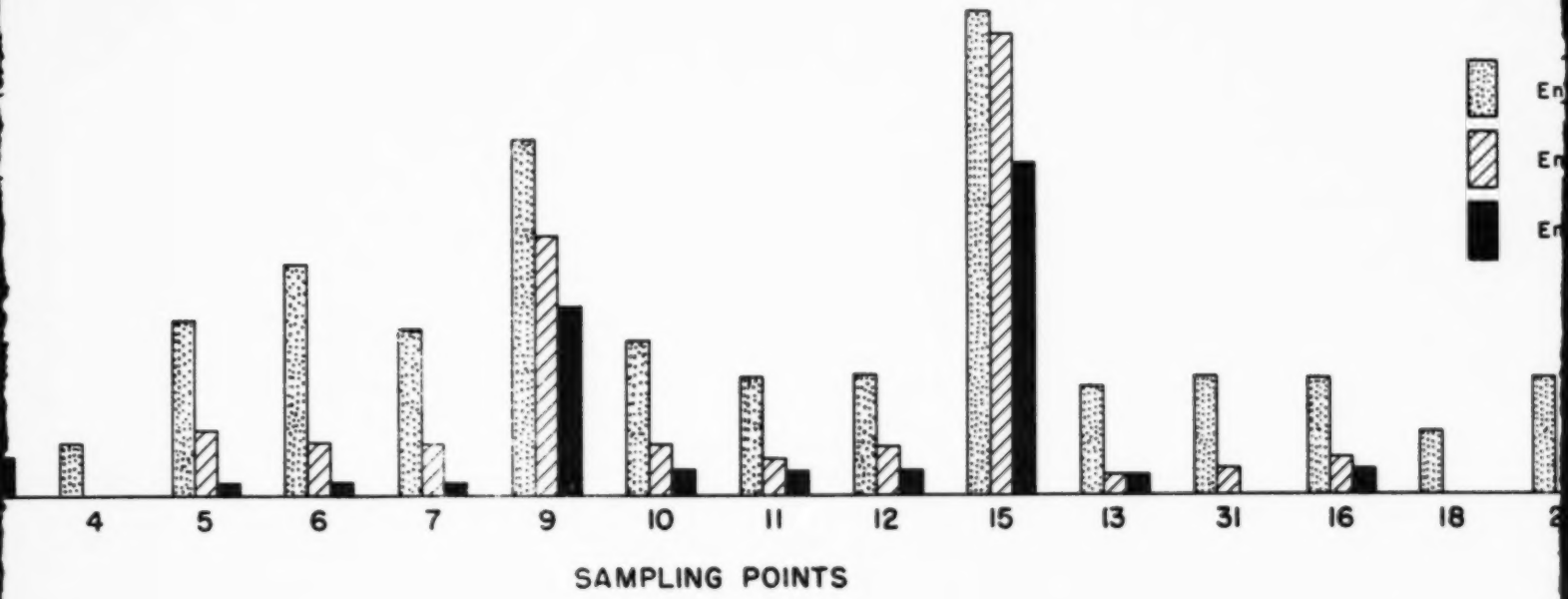
Table Lake 3 (cont'd)

Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
				LAKE FOREST			
18	46,000	3	122	156	23	-3	-3
19(S)	11,000	-30	230	197	—	—	—
				FORT SHERIDAN			
20	46,000	-3	122	164	43	-3	-3
				HIGHLAND PARK			
22	46,000	23	240	320	150	-3	-3
23	21,000	-3	92	102	39	-3	-3
24	110,000	-3	91	150	9.1	-3	-3
25(S)	⊖+110,000	-30	-30	72	—	—	—
28(S)	930	-30	-30	33	—	—	—
27	9,300	-3	93	174	23	-3	-3
30(S)	11,000	-30	230	267	—	—	—
29	110,000	7.3	135	243	23	-3	-3

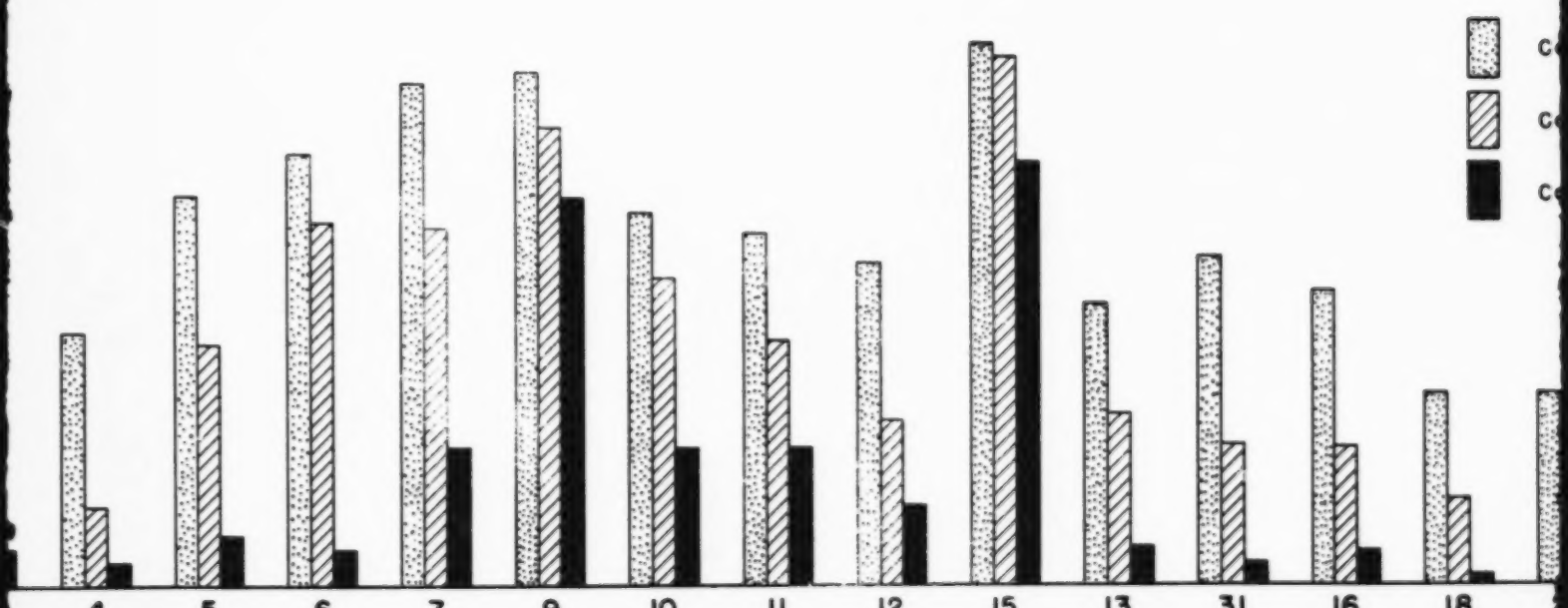
⊖ - Maximum occurred on day without chlorination
* - August only
(S) - Sewage treatment plant effluent (chlorinated)
R- - Water plant intake
- indicates MPN indeterminate, but less than figure given
+ indicates MPN indeterminate, but greater than figure given


A
ENTEROCOCCUS
Percent of Samples
100
80
60
40
20
0
37
36
35
34
33
1
3
4
5
6
COLIFORM
Percent of Samples
100
80
60
40
20
0
37
36
35
34
33
1
3
4
5
6

13



SAMPLING POINTS



SAMPLING POINTS

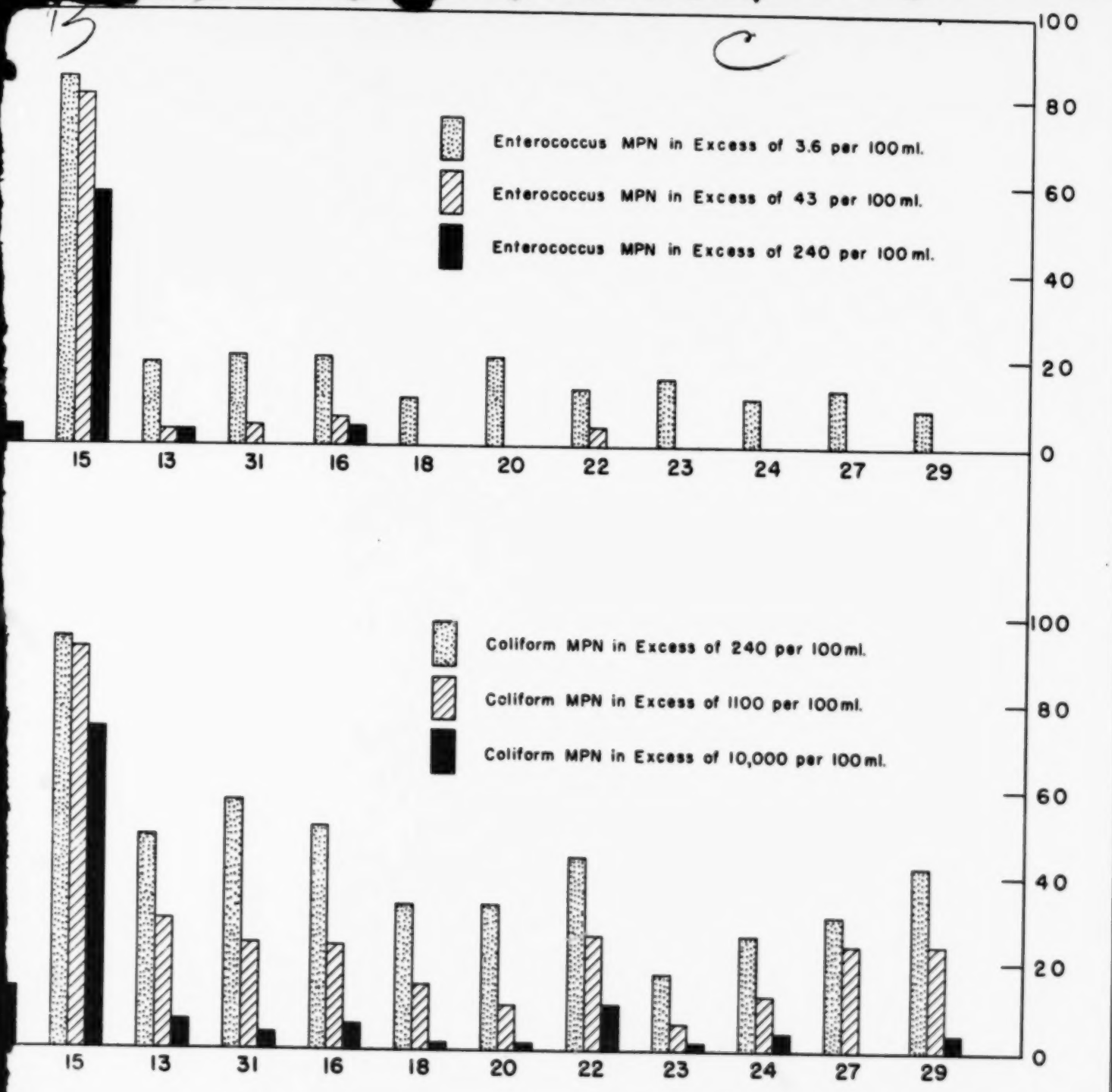


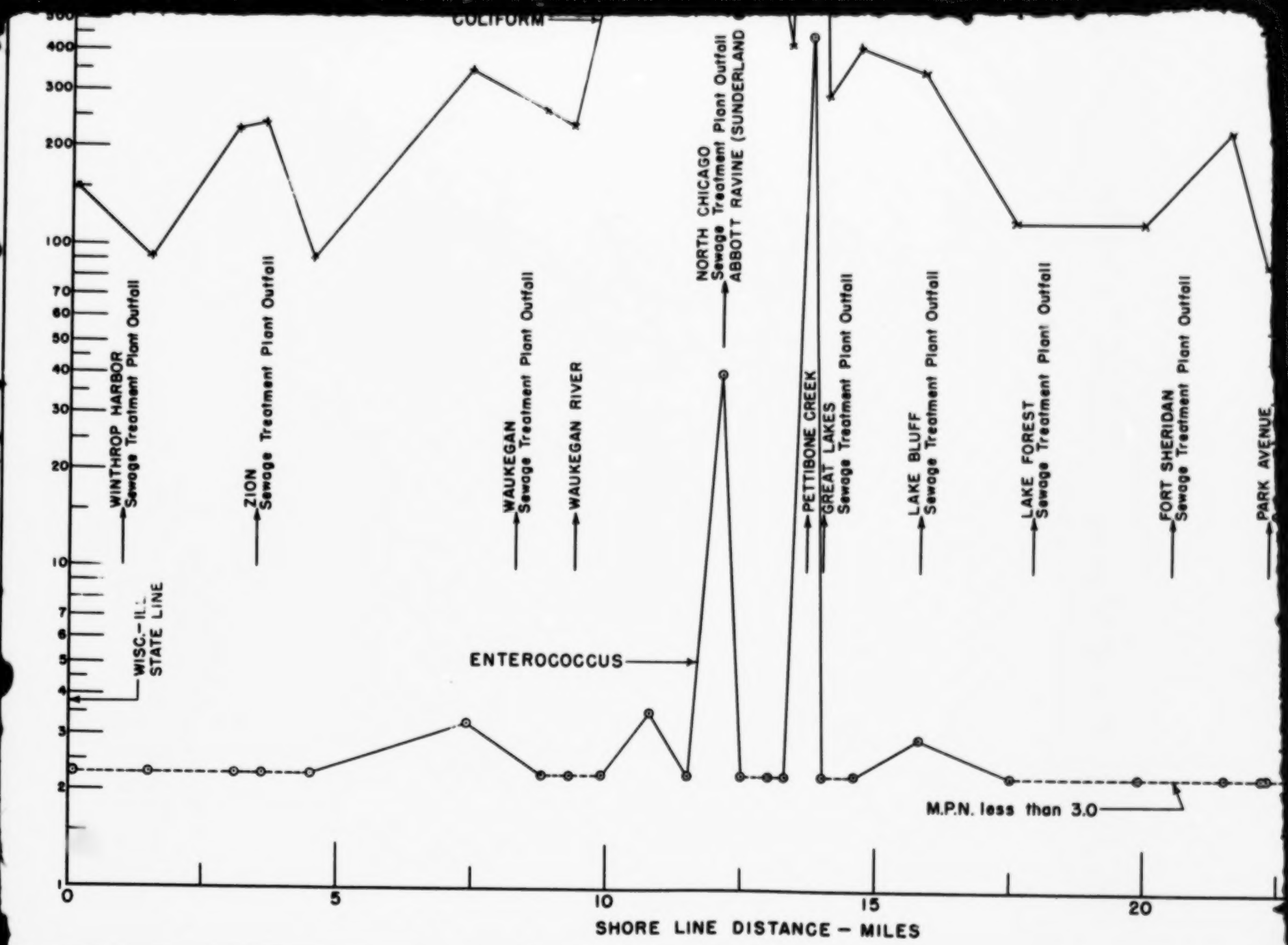
FIG. LAKE 1

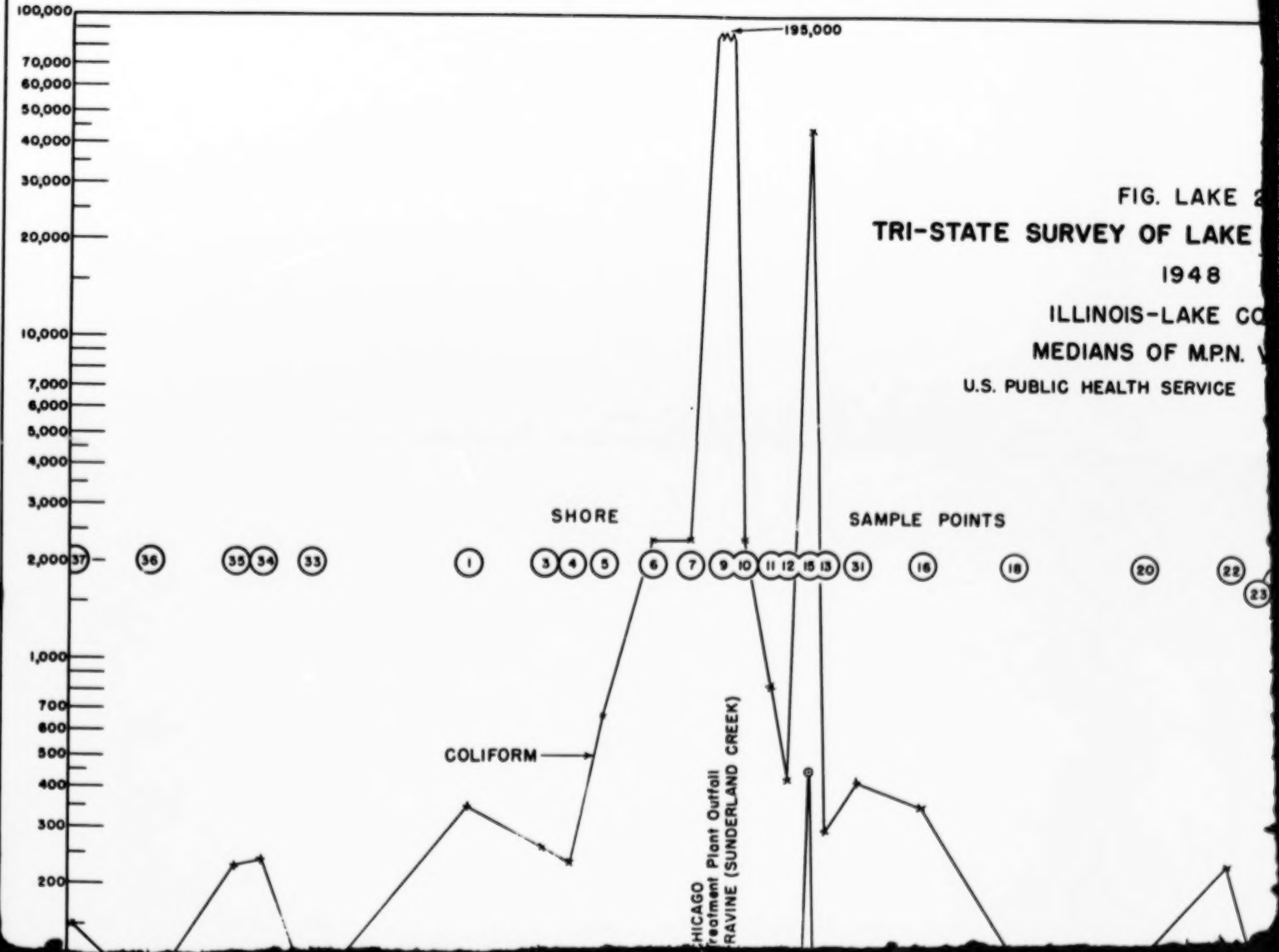
Tri-State Survey of Lake Michigan Waters
Relation of Coliform & Enterococcus

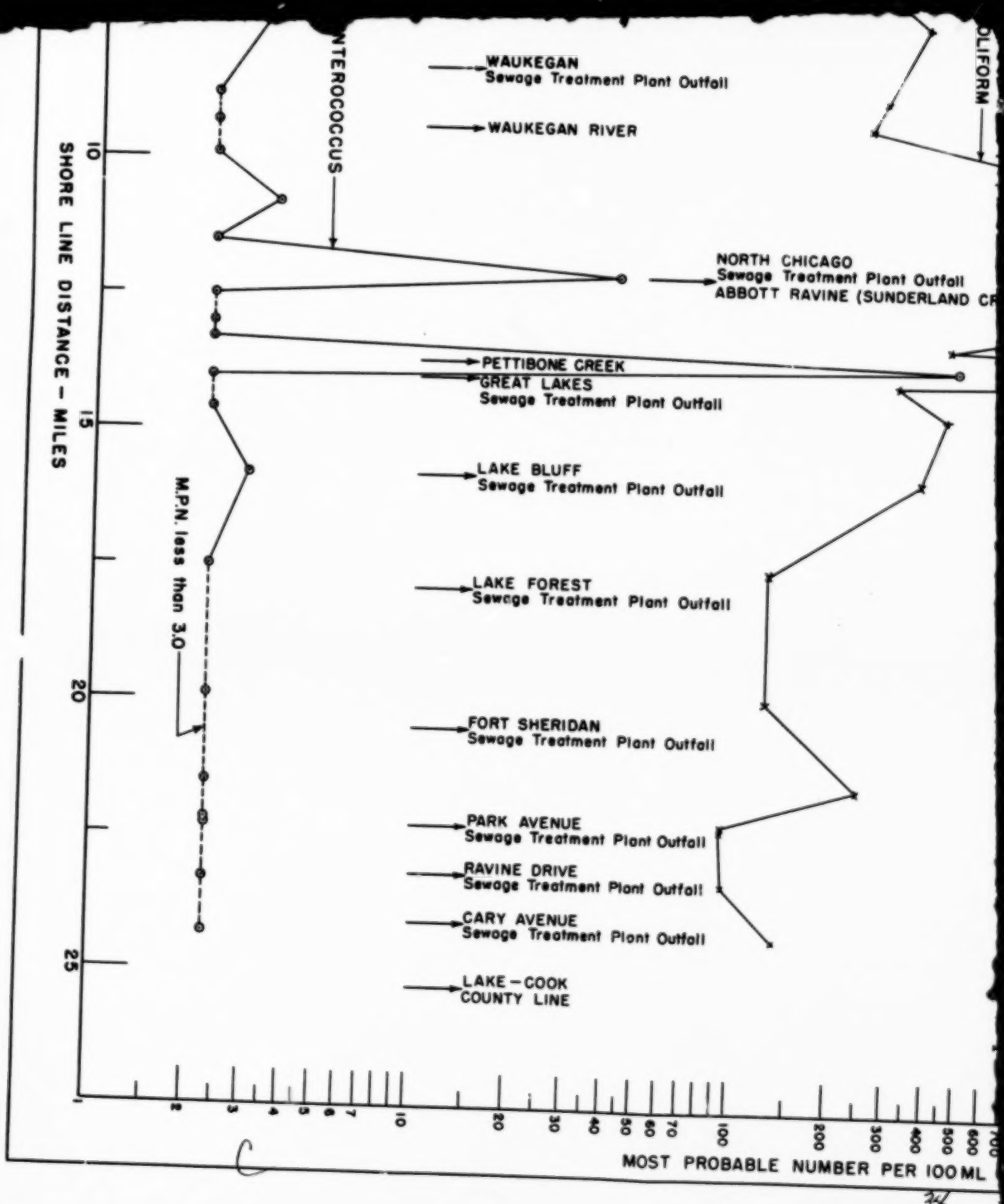
Illinois—Lake County
June-July-August

U.S.P.H.S.
Cincinnati, Ohio

Environmental Health Center
December 1948


COLIFORM
WINTHROP HARBOR
Sewage Treatment Plant Outfall
ZION
Sewage Treatment Plant Outfall
WAUKEGAN
Sewage Treatment Plant Outfall
WAUKEGAN RIVER
NORTH CHICAGO
Sewage Treatment Plant Outfall
ABBOTT RAVINE (SUNDERLAND
PETTIBONE CREEK
GREAT LAKES
Sewage Treatment Plant Outfall
LAKE BLUFF
Sewage Treatment Plant Outfall
LAKE FOREST
Sewage Treatment Plant Outfall
FORT SHERIDAN
Sewage Treatment Plant Outfall
PARK AVENUE
WISC.-ILL.
STATE LINE
ENTEROCOCCUS
M.P.N. less than 3.0
500
400
300
200
100
70
60
50
40
30
20
10
7
6
5
4
3
2
1
0
5
10
15
20
SHORE LINE DISTANCE – MILES


100,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
700
600
500
400
300
200
195,000
SHORE
SAMPLE POINTS
37
36
35
34
33
1
3
4
5
6
7
9
10
11
12
15
13
31
16
18
20
22
23
COLIFORM
CHICAGO
Treatment Plant Outfall
RAVINE (SUNDERLAND CREEK)
FIG. LAKE
TRI-STATE SURVEY OF LAKE
1948
ILLINOIS-LAKE CO
MEDIANS OF M.P.N.
U.S. PUBLIC HEALTH SERVICE


ENTEROCOCCUS
COLIFORM
WAUKEGAN
Sewage Treatment Plant Outfall
WAUKEGAN RIVER
NORTH CHICAGO
Sewage Treatment Plant Outfall
ABBOTT RAVINE (SUNDERLAND CR
PETTIBONE CREEK
GREAT LAKES
Sewage Treatment Plant Outfall
LAKE BLUFF
Sewage Treatment Plant Outfall
LAKE FOREST
Sewage Treatment Plant Outfall
FORT SHERIDAN
Sewage Treatment Plant Outfall
PARK AVENUE
Sewage Treatment Plant Outfall
RAVINE DRIVE
Sewage Treatment Plant Outfall
CARY AVENUE
Sewage Treatment Plant Outfall
LAKE – COOK
COUNTY LINE
M.P.N. less than 3.0
SHORE LINE DISTANCE – MILES
10
15
20
25
1
2
3
4
5
6
7
10
20
30
40
50
60
70
100
200
300
400
500
600
700
MOST PROBABLE NUMBER PER 100 ML

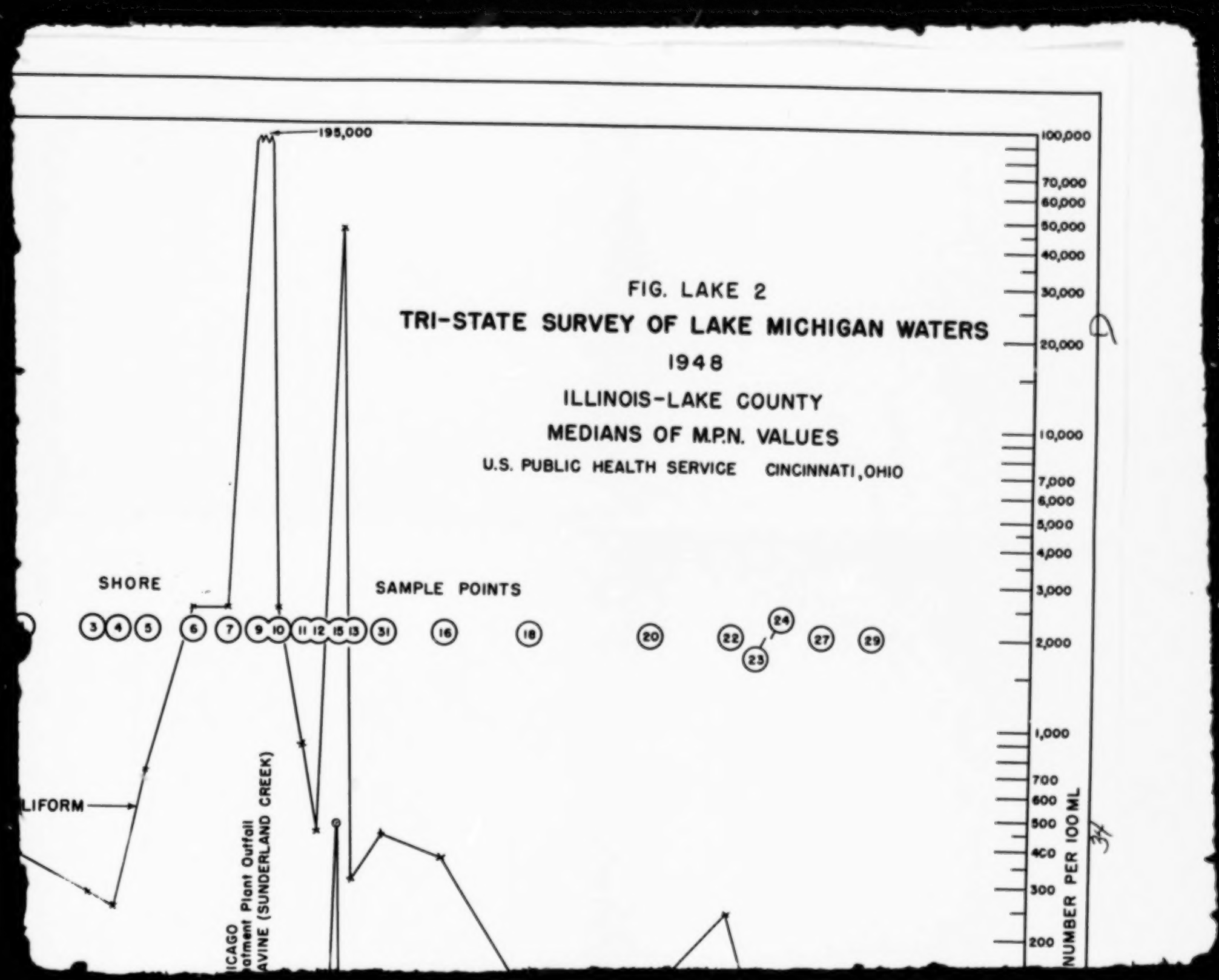


FIG. LAKE 2
TRI-STATE SURVEY OF LAKE MICHIGAN WATERS
1948
ILLINOIS-LAKE COUNTY
MEDIANS OF M.P.N. VALUES
U.S. PUBLIC HEALTH SERVICE CINCINNATI, OHIO
195,000
SHORE
SAMPLE POINTS
3 4 5 6 7 9 10 11 12 15 13 31 16 18 20 22 24 23 27 29
LIFORM
ICAGO
atment Plant Outfall
AVINE (SUNDERLAND CREEK)
100,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
700
600
500
400
300
200
NUMBER PER 100 ML

DISCUSSION

The shore waters in the North Chicago-Great Lakes Naval Training Center area give evidence of the greatest pollution of any area along the Lake County shoreline. Bacterial densities, both coliform and enterococcus, are greater here than in the other areas. This is evidently due to the wastes carried to the lake by Sunderland and Pettibone Creeks, and by outlets discharging directly to the lake. The effect of wastes in Pettibone Creek is believed to be somewhat dampened by the stilling action of the inner and outer harbors to which it discharges.

Apparently the sewage treatment plant at the Great Lakes Naval Training Center does not contribute coliform pollution in significant amounts to the adjacent waters. Samples taken from the plant outfall have a lower coliform density than those from the beaches north of the harbor and even lower than those from the outer end of the breakwater 2000 feet out in the lake. It is to be noted, however, that the enterococcus density of the outfall samples is high, approximating the density of the samples taken off Abbott Ravine.

The waters at the beaches at Camp Logan, Illinois State Beach Park, Waukegan Water Works, Fort Sheridan, and Park and Central Avenues in Highland Park would be classified among the best group in the entire survey. The shore waters at Water Street, Waukegan and the North Chicago-Great Lakes area would be in the poorest grouping. All the other areas in Lake County would come under an intermediate grouping showing moderate pollution, possibly of a sporadic nature.

There is apparently no hazard from existing pollution along the lake shore to the public water supplies so long as proper treatment is maintained. The available data indicated that the coliform counts of the raw waters for the treatment plants conformed to the sanitary requirements recommended in Public Health Bulletin No. 296 (Manual of Recommended Water-Sanitation Practice, 1946). The highest monthly average coliform density for raw water was at North Chicago during July when the average was 810 per 100 ml. with four samples (17%) exceeding 1100, one (4%) exceeding 5000 and none with an MPN of 10,000. Some care was necessary at North Chicago and Waukegan to minimize tastes and odors in the water supplies.

The discharge from Sunderland Creek must be investigated further to determine its pollutional significance. However, consideration of the results of the samples collected in the lake near the mouth of the creek would indicate that these wastes are a source of objectionable pollution. The treatment of the wastes from pharmaceutical manufacturing constitutes a major problem in this area.

Bacteriological examinations of the ravine waters (not reported here) revealed that only one ravine discharged pollution in significant amounts where the source was from domestic sewers or private residences. Sunderland and Pettibone Creeks, which carry large amounts of industrial wastes, showed consistently high bacterial indices throughout the survey.

Appendix C

SURVEY IN ILLINOIS (COOK COUNTY)

Prepared
by
U. S. Public Health Service
Environmental Health Center

CONCLUSIONS

1. The results of the survey of the shore waters along the Cook County lake front indicate that the beaches north of the Calumet Harbor breakwater, with few exceptions, rank among the best areas in the entire survey.

   (a) The laboratory results confirm sanitary surveys which show no evidence of significant direct sewage or industrial waste pollution entering the lake in this area.

   (b) The small boat harbors maintained by the Chicago Park District do not contribute a significant amount of pollution to the lake.

2. The shore waters along the Cook County lake front south of the Calumet Harbor breakwater have extremely high coliform densities for natural Lake Michigan shore water. These bacteriological results are many times higher than those for any other shore waters in this county.

   (a) Careful sanitary surveys of the industrial establishments in this area in Illinois fail to show evidence of bacterial pollution of the lake by sewage or industrial wastes from these plants which could cause the high coliform densities observed.

   (b) There is no appreciable evidence of extreme bacterial pollution from either the Calumet River or the Indiana Harbor Canal sufficient to account for the extremely high coliform densities found on the beaches in this area.

   (c) An industrial waste of extremely high coliform density enters the lake about 2000 feet northwest of Lake Front Beach in Hammond, Indiana. These high densities are reflected in the results from the samples taken on the Hammond beach and may be the cause of the high results obtained at the Calumet Park Beaches.

   (d) The Advisory Board passed a resolution on July 23, that it was their opinion that the public should be informed that swimming is not recommended at the beaches in this area at this time.

SAMPLE POINTS

A total of 34 routine sample points were established along the Cook County lake front. These were set on all organized public beaches, several street end beaches, and at the channel entrances to the small boat harbors of the Chicago Park District. One sample point was established in Lake County, Illinois, and two in Indiana in order to obtain an overlapping of samples with the agencies working in those areas. The beach sample points were located where it was believed that the maximum bathing load would occur. All sample points were carefully located and described in reference to prominent fixed objects in order that sampling should always be done at the same place and that the same points might be used in future surveys.

During the period from June 1 to August 29, each of these points, with the exception of 18A (Burnham Harbor entrance) was sampled from 22 to 44 times. In general, each point was sampled three times a week, with an effort made to vary the sampling time over the daylight hours and over the various days of the week. Point 18A was sampled only eight times.

The general locations of the various sample points are given in Table Cook 1.

TABLE COOK 1

SAMPLE POINTS

1	Highland Park (Lake County) - Cary Ave. Beach
*R-1	Glencoe - Raw water intake
2	Glencoe - Lake Front Park Beach
*R-2	Winnetka - Raw water intake
2A	Winnetka - Tower Road Beach
3	Winnetka - Lake Front Park Beach
4	Winnetka - Elder Lane Park Beach
*R-3	Kenilworth - Raw water intake
5	Wilmette - Water Works Park Beach
*R-4	Wilmette - Raw water intake
*R-5	Evanston - Raw water intake
6	Evanston - University Place beach
7	Evanston - Lee Street beach
8	Evanston - South Boulevard beach
9	Chicago - Rogers Park Beach
S-2	Chicago - Pratt Boulevard street end beach
S-3	Chicago - Albion Avenue street end beach
10	Chicago - Foster Avenue beach
11	Chicago - Montrose Avenue Beach
#12	Chicago - Montrose Harbor entrance
*R-6	Chicago - Wilson Avenue Crib raw water
#13	Chicago - Belmont Harbor entrance
#14	Chicago - Diversey Harbor entrance
15	Chicago - North Avenue Beach, north end
16	Chicago - North Avenue Beach, south end
*R-7	Chicago - Carter Harrison Crib raw water
17	Chicago - Oak Street Beach
*R-8	Chicago - Four Mile Crib raw water
18	Chicago - Northerly Island Beach
#18A	Chicago - Burnham Harbor entrance
19	Chicago - 31st Street Beach
20	Chicago - 49th Street paved beach
21	Chicago - 57th Street Beach
#22	Chicago - 59th Street Harbor entrance
23	Chicago - Jackson Park Beach
#24	Chicago - Jackson Park Harbor entrance
*R-9	Chicago - Dunne Crib raw water
S-4	Chicago - 73rd Street private beach
S-5	Chicago - 74th Street street end beach
24A	Chicago - Rainbow Beach, north end
25	Chicago - Rainbow Beach, south end
*25A	Chicago - Calumet River
26	Chicago - Calumet Park outer beach
27	Chicago - Calumet Park bathing beach
28	Hammond (Indiana) - Lake Front Beach
29	Whiting (Indiana) - Municipal Beach

*Not a shore sample
#Harbor mouth sample

SANITARY CONDITIONS

Sanitary Sewage

All sanitary sewage in the communities along the lake shore in Cook County is diverted to the intercepting sewers and sewage treatment plants of The Sanitary District of Chicago and the effluents discharge to the various Sanitary District channels which in turn discharge into the Desplaines River at Lockport and thence to the Illinois River, tributary to the Mississippi River.

Chicago, Evanston, Kenilworth and a part of Wilmette have combined sewers so that in time of storm the flows in excess of the capacity of Sanitary District interceptors discharge to the water courses. The controls in the diversion structures are set to discharge the dry weather flow plus a portion of storm water runoff to the interceptors. All but a few of the overflows discharge to the channel system and hence are normally prevented from reaching the lake. There are known to be six overflows from the combined sewer systems which discharge to the lake in times of heavy storm. One of these is in the village of Kenilworth about two miles north of Wilmette Harbor and the other five are in Evanston. These overflows were inspected the latter part of May, shortly after the spring rainy season when they might have been expected to have discharged. Two of them were below lake water level. The inspection of three others revealed no signs of recent discharge. One overflow was not located. According to The Sanitary District of Chicago, only one of the Evanston relief overflows (that at Davis Street) is in service at the present time, the others being temporarily blocked by sand.

The villages of Glencoe, Winnetka and part of Wilmette on the lake shore in the north part of the county have separate sewer systems with the sanitary sewage discharging to The Sanitary District of Chicago interceptors. The storm sewers discharge to Lake Michigan in parts of Glencoe and Winnetka.

Under normal conditions there is little probability of pollution reaching the lake from the North Shore Channel or the Chicago River. This is due to the barrier dam and lock at Wilmette Harbor and to the bulkhead system and lock at the mouth of the Chicago River. The Wilmette dam and lock serves as an intake to the North Shore Channel and the water level at the mouth of the Chicago River is maintained at a lower elevation than the lake except under unusual storm runoff conditions. The level in the mouth of the Chicago River is normally held at approximately -0.8 Chicago City Datum except when Lake Michigan is below this elevation. At such times it is held at approximately 0.2 ft. below lake level. Since the bulkhead system and the lock at the mouth of the Chicago River were put into service on September 7, 1938, there have been no flows into the lake at this point. There is record of only four occasions since 1935 when unusually heavy storm runoff caused the North Shore Channel to overflow the lock gates at Wilmette Harbor. The last reversal occurred March 19, 1948.

The flow in the Calumet River is normally away from the lake although there is only a small current. The amount of lake diversion is controlled by operation of the locks at Blue Island, fourteen miles inland from the mouth, and is ordinarily sufficient to prevent reversals. However, there are no locks at the mouth of the river. Observations of apparent directions of flow during this survey indicated that on three occasions there was a slight movement of the surface water toward the lake. On two of these occasions the prevailing wind was such that these water movements might have been due to wind effects on the river surface. In the third instance the prevailing wind was from the lake. According to records of The Sanitary District of Chicago, there were only two measurable reversals in 1948, totalling 117 hours, but neither of these occurred during the survey.

Industrial Flows

The shore line from 79th Street to the Indiana state line is almost completely occupied by industry. There are two large mills producing pig iron and two malting companies located in this area. Sanitary surveys of these plants showed that all sanitary wastes were discharged to the Chicago sewers as were the industrial wastes from the malting plants. Cooling water, quenching water and gas washer wastes from the steel mills discharge to the lake and to the Calumet River. The gas washer wastes contain considerable iron ore dust. Although these wastes are passed through Dorr clarifiers to reclaim the ore, much of the fine material reaches the lake in Calumet Harbor and gives a distinct reddish tinge to the water. It is not considered that this is of sanitary significance. Only one of the steel companies operates a coke plant at this location and the phenolic waste from it is discharged to Chicago sewers.

Storm Drainage

Storm sewer outlets in Glencoe and Winnetka which drain into the lake have been mentioned.

A survey in Chicago indicated that there are 112 storm water drains in the parks along the lake front. Most of these discharge into the various boat harbors. The results of samples taken at frequent intervals from the outlets of these harbors indicate that these drains have no significant effect on the sanitary quality of the shore waters. In addition to these storm drains in the parks, there are many surface or gutter drains serving short street ends abutting on the lake shore and several storm outlets in areas not included in the park system.

Special Conditions

During the entire period of the survey a structure to provide dressing room and toilet facilities was under construction at Elder Lane Park Beach, Winnetka. The excavation and work on the beach may explain the higher than average coliform density of the shore water at this point. The beach was not heavily used during the summer of 1948.

LABORATORY EXAMINATIONS

During the summer a total of 1246 routine samples were collected from the 37 sampling points in the area. The densities of coliform and enterococcus organisms were determined on each sample.

The results are presented in Table Cook 2 as an MPN distribution table for coliform and enterococcus and graphically in Figure Cook 1. Table Cook 3 shows the maximum, minimum, median and logarithmic average MPN for each sample point. The logarithmic average was not computed when the majority of the results were indeterminate. Figure Cook 2 shows graphically the medians of the coliform and enterococcus MPN for each point.

TABLE COOK 2

BACTERIOLOGICAL RESULTS

FREQUENCY DISTRIBUTION

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
					HIGHLAND PARK (LAKE COUNTY)					
1	30	13.4	6.7	3.3	0.0	30	13.4	10.0	3.3	0.0
					GLENCOE					
R-1	23	4.4	4.4	0.0	0.0	0	—	—	—	—
2	31	12.9	12.9	3.2	0.0	31	19.3	12.9	6.4	0.0
2A	22	9.1	9.1	4.6	0.0	22	13.6	9.1	4.6	0.0
					WINNETKA					
R-2	78	2.6	0.0	0.0	0.0	0	—	—	—	—
3	31	22.6	9.7	0.0	0.0	31	13.0	6.5	3.2	3.2
4	31	48.4	25.8	16.1	0.0	31	19.3	19.3	6.4	3.2
					KENILWORTH					
R-3	34	0.0	0.0	0.0	0.0	0	—	—	—	—
					WILMETTE					
5	31	9.7	3.2	0.0	0.0	31	19.3	9.7	3.2	3.2
R-4	76	1.3	1.3	0.0	0.0	0	—	—	—	—
					EVANSTON					
R-5	92	0.0	0.0	0.0	0.0	0	—	—	—	—
6	33	18.2	12.1	0.0	0.0	33	24.2	12.1	3.0	0.0
7	35	20.0	17.1	0.0	0.0	35	25.7	14.3	11.4	0.0
8	35	17.1	2.9	0.0	0.0	35	25.7	17.1	5.7	2.9
					CHICAGO					
9	37	10.8	2.7	0.0	0.0	37	13.5	8.1	2.7	0.0
S-2	36	22.2	8.3	2.8	0.0	36	30.6	16.7	5.6	0.0
S-3	31	12.9	0.0	0.0	0.0	31	16.1	16.1	0.0	0.0
10	37	13.5	8.1	5.4	0.0	37	21.6	18.9	2.7	2.7
11	38	23.7	5.3	0.0	0.0	38	21.1	10.5	2.6	0.0
12	34	0.0	0.0	0.0	0.0	34	11.8	5.9	0.0	0.0
R-6	61	1.6	1.6	1.6	0.0	0	—	—	—	—
13	33	6.1	3.0	0.0	0.0	33	9.1	9.1	3.0	0.0
14	32	6.3	6.3	0.0	0.0	32	6.3	3.1	0.0	0.0
15	38	10.5	0.0	0.0	0.0	38	10.5	2.6	0.0	0.0
16	38	18.4	7.9	5.3	0.0	38	21.1	15.8	5.3	0.0
R-7	61	0.0	0.0	0.0	0.0	0	—	—	—	—
17	35	25.7	17.1	2.9	0.0	35	22.9	14.3	5.7	0.0
R-8	60	0.0	0.0	0.0	0.0	0	—	—	—	—
18	36	13.9	5.6	2.8	0.0	36	22.2	13.9	5.6	2.8

(cont'd)

Table Cook 2 (cont'd)

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
18A	8	25.0	12.5	0.0	0.0	8	25.0	12.5	0.0	0.0
19	37	18.9	13.5	2.7	0.0	37	21.6	16.2	5.4	2.7
20	36	8.3	7.7	0.0	0.0	36	13.9	8.2	0.0	0.0
21	37	29.7	10.8	2.7	0.0	37	8.1	8.1	2.7	2.7
22	35	14.3	5.7	0.0	0.0	35	31.4	14.3	5.7	0.0
23	36	44.4	38.5	13.9	2.8	36	25.0	11.1	5.6	2.8
24	32	21.9	9.4	3.1	0.0	32	37.5	25.0	6.3	3.1
R-9	57	10.5	8.8	1.8	0.0	0	—	--	---	—
S-4	37	24.3	16.2	5.4	2.7	37	21.6	13.5	5.4	2.7
S-5	36	36.1	16.7	13.9	0.0	36	30.6	25.0	2.8	0.0
24A	44	31.8	25.0	11.4	0.0	44	15.9	9.1	2.3	0.0
25	43	32.6	16.3	7.0	0.0	43	11.6	9.3	4.7	0.0
25A	28	82.1	68.0	57.1	10.7	28	32.1	25.0	0.0	0.0
26	39	84.6	79.5	59.0	17.9	39	12.8	7.7	0.0	0.0
27	40	82.5	70.0	62.5	30.0	40	10.0	10.0	5.0	2.5
				HAMMOND, INDIANA						
28	36	100.0	100.0	97.2	83.3	36	27.8	25.0	11.1	2.8
				WHITING, INDIANA						
29	35	97.1	94.3	82.9	51.4	35	17.1	11.4	11.4	0.0

* Most probable number per 100 ml.
R- Water plant intake

TABLE COOK 3

BACTERIOLOGICAL RESULTS

DENSITIES
MPN per 100 ml.

Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
			HIGHLAND PARK (LAKE COUNTY)				
1	2400	3.6	67	54	75	-3	-3
			GLENCOE				
R-1	1100	9.1	43	—	—	—	—
2	4600	-3	33	58	240	-3	-3
2A	4600	15	43	70	240	-3	-3
			WINNETKA				
R-2	460	3.0	9.1	—	—	—	—
3	1100	3.6	43	79	460	-3	-3
4	4600	23	240	207	460	-3	-3
			KENILWORTH				
R-3	240	-3	13	—	—	—	—
			WILMETTE				
5	1100	3.6	43	61	460	-3	-3
R-4	1100	-3	-9	—	—	—	—
			EVANSTON				
R-5	93	-3	-3	—	—	—	—
6	+1100	-3	43	53	150	-3	-3
7	+1100	-3	43	77	240	-3	-3
8	+1100	-3	43	58	460	-3	3.0
			CHICAGO				
9	1100	-3	43	33	240	-3	-3
S-2	2400	-3	93	94	93	-3	-3
S-3	460	3.6	43	63	43	-3	-3
10	2300	-3	43	57	1100	-3	-3
11	1100	9.1	43	80	93	-3	-3
12	240	-3	33	34	9.1	-3	-3
R-6	3000	-0.18	1.4	—	—	—	—
13	1100	9.1	43	53	93	-3	-3
14	930	-3	36	49	20	-3	-3
15	460	9.1	40	50	15	-3	-3
16	9300	3.6	83	85	240	-3	-3
R-7	12.5	-0.18	-0.18	—	—	—	—
17	2400	-3	91	92	93	-3	-3
R-8	57	-0.18	1.0	—	—	—	—
18	2300	3.6	91	83	460	-3	-3

(cont'd)

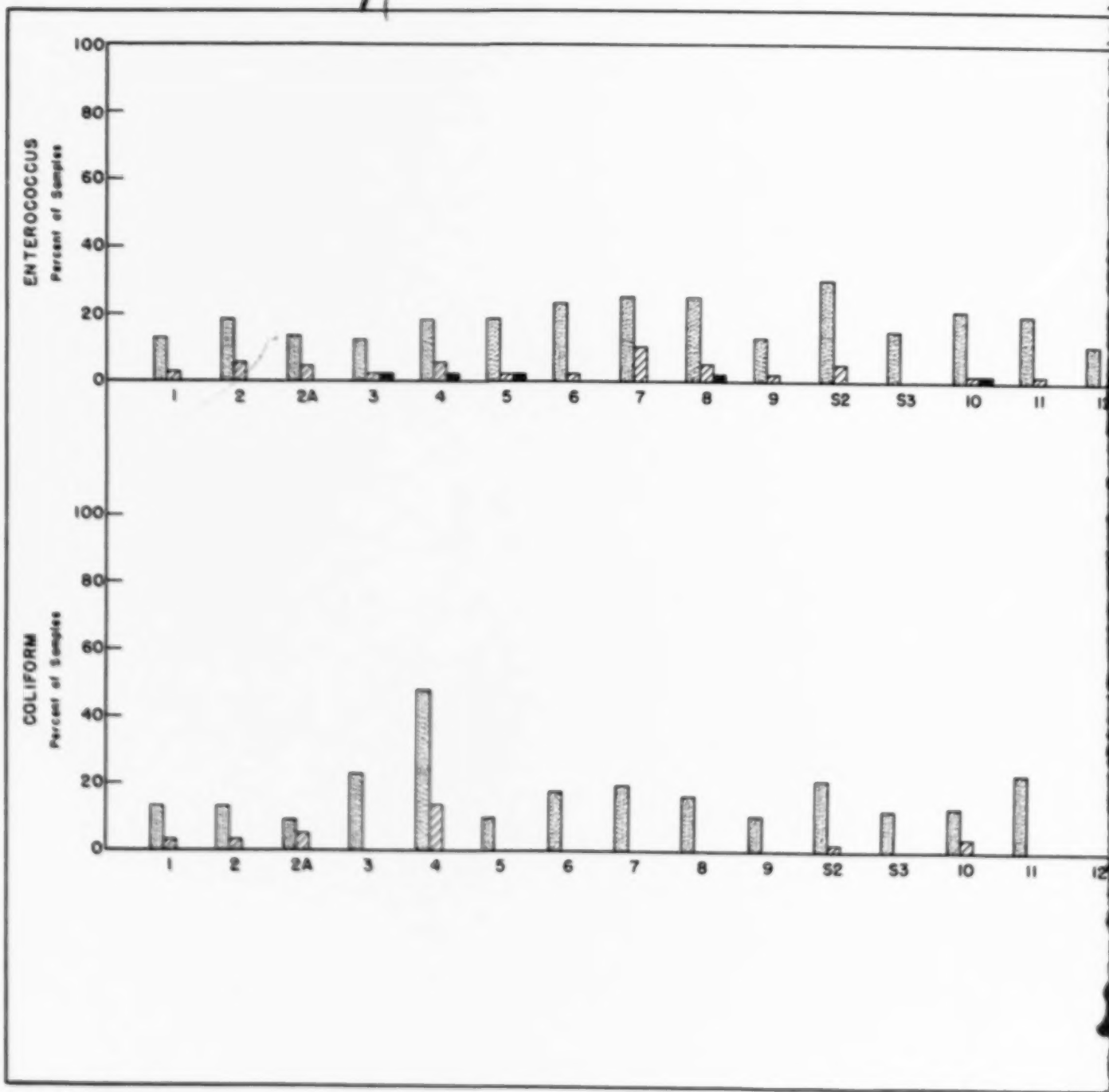
Table Cook 3 (cont'd)

Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
18A	1100	3.6	23	35	43	-3	-3
19	2400	3.6	150	122	1100	-3	-3
20	1100	-3	33	34	43	-3	-3
21	2400	9.1	230	158	460	-3	-3
22	1100	23	240	185	240	-3	-3
23	24,000	-3	230	169	+1100	-3	-3
24	2400	9.1	93	112	1200	-3	3.6
R-9	1700	-0.18	23	—	—	—	—
S-4	24,000	-3	93	115	460	-3	-3
S-5	4300	-3	230	178	93	-3	-3
24A	7500	3.6	190	156	240	-3	-3
25	4600	3.6	230	155	93	-3	-3
25A	24,000	91	1950	1640	43	-3	3.3
26	46,000	23	2400	2340	43	-3	-3
27	93,000	93	2400	3110	1100	-3	-3
			HAMMOND, INDIANA				
28	24,000,000	2400	130,000	106,000	460	-3	-3
			WHITING, INDIANA				
29	2,400,000	-300	15,000	18,900	240	-3	-3

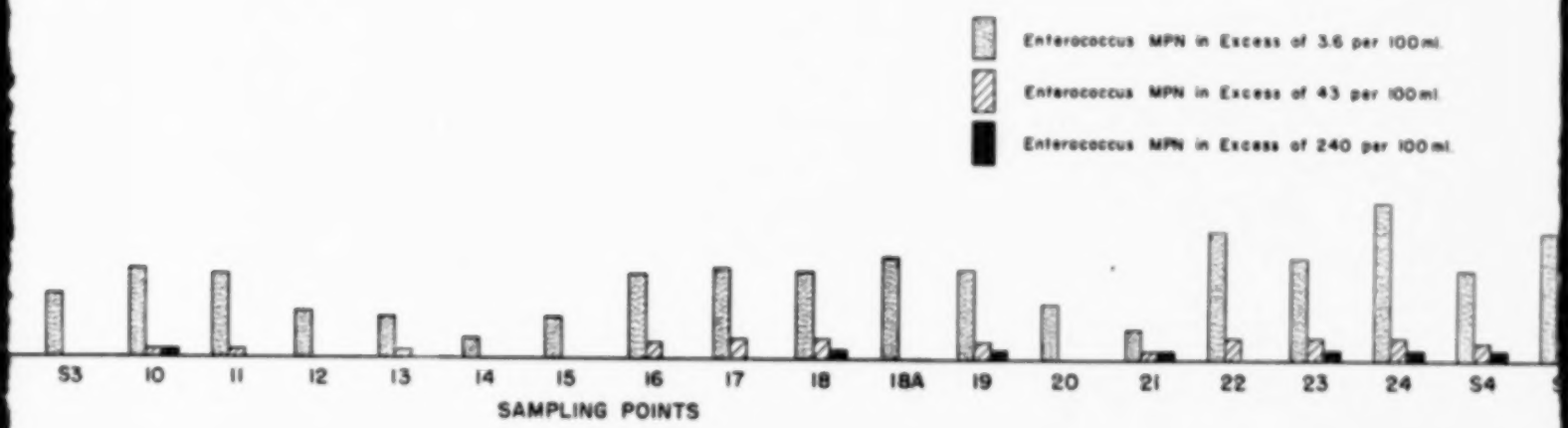
- indicates MPN indeterminate, but less than figure given

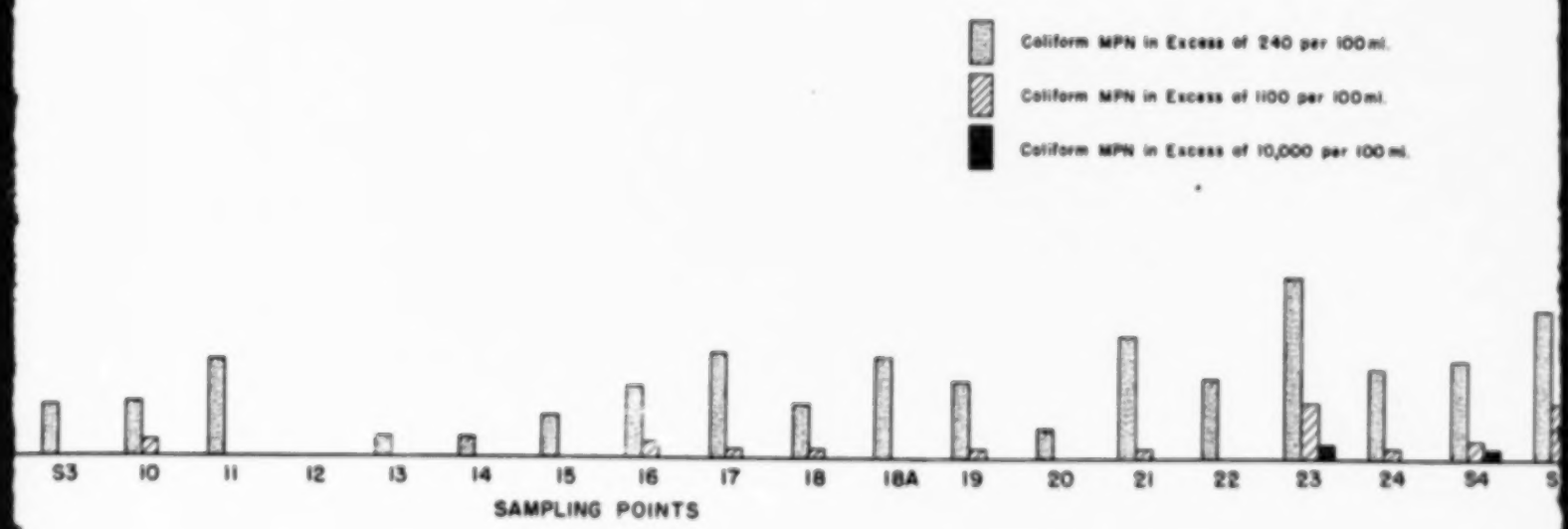
+ indicates MPN indeterminate, but greater than figure given

A


ENTEROCOCCUS
Percent of Samples
100
80
60
40
20
0
1
2
2A
3
4
5
6
7
8
9
S2
S3
10
11
COLIFORM
Percent of Samples
100
80
60
40
20
0
1
2
2A
3
4
5
6
7
8
9
S2
S3
10
11
12

B


Enterococcus MPN in Excess of 3.6 per 100 ml.
Enterococcus MPN in Excess of 43 per 100 ml.
Enterococcus MPN in Excess of 240 per 100 ml.
S3
10
11
12
13
14
15
16
17
18
18A
19
20
21
22
23
24
S4
SAMPLING POINTS


Coliform MPN in Excess of 240 per 100 ml.
Coliform MPN in Excess of 1100 per 100 ml.
Coliform MPN in Excess of 10,000 per 100 ml.
S3
10
11
12
13
14
15
16
17
18
18A
19
20
21
22
23
24
S4
SAMPLING POINTS

C

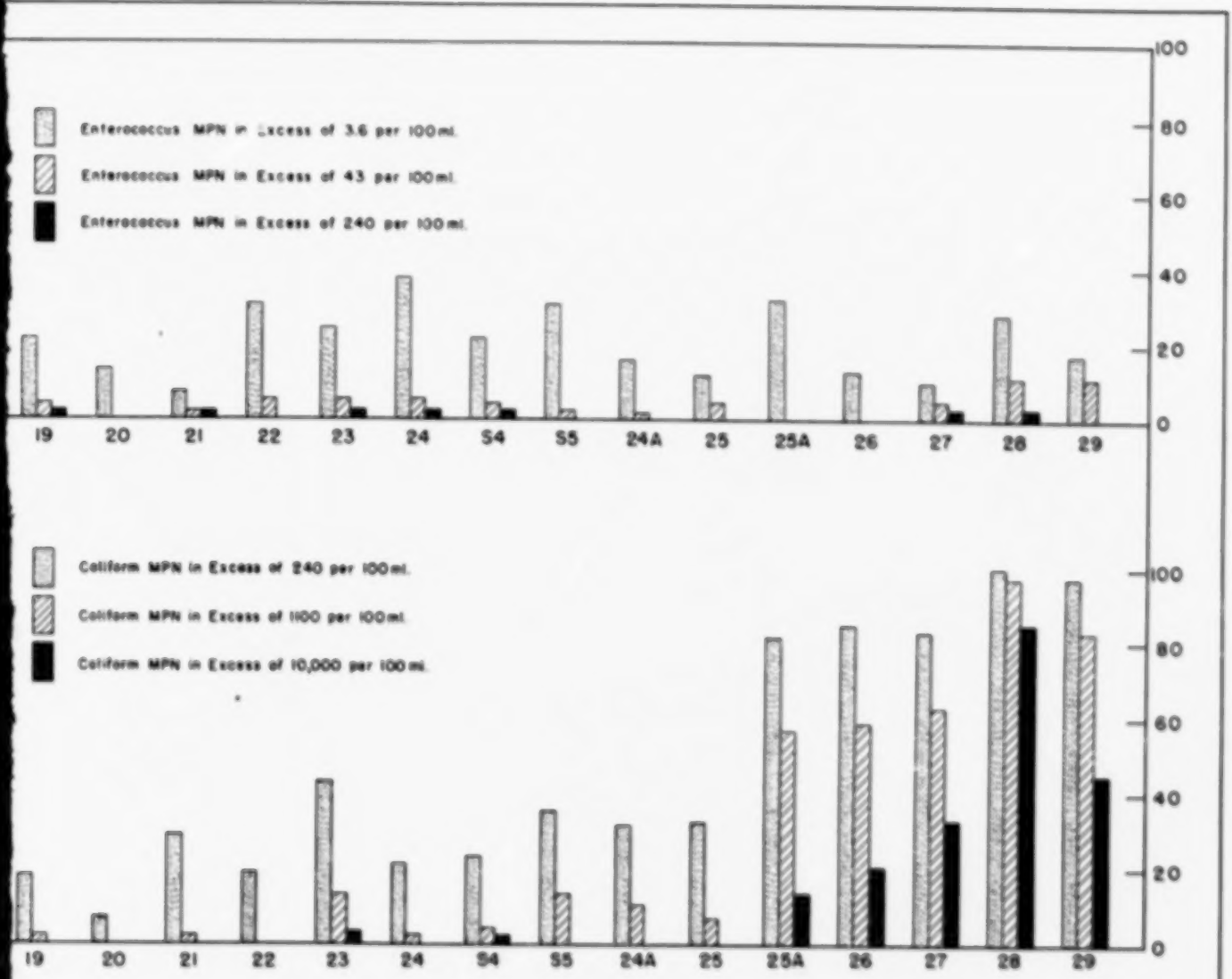


FIG. COOK 1

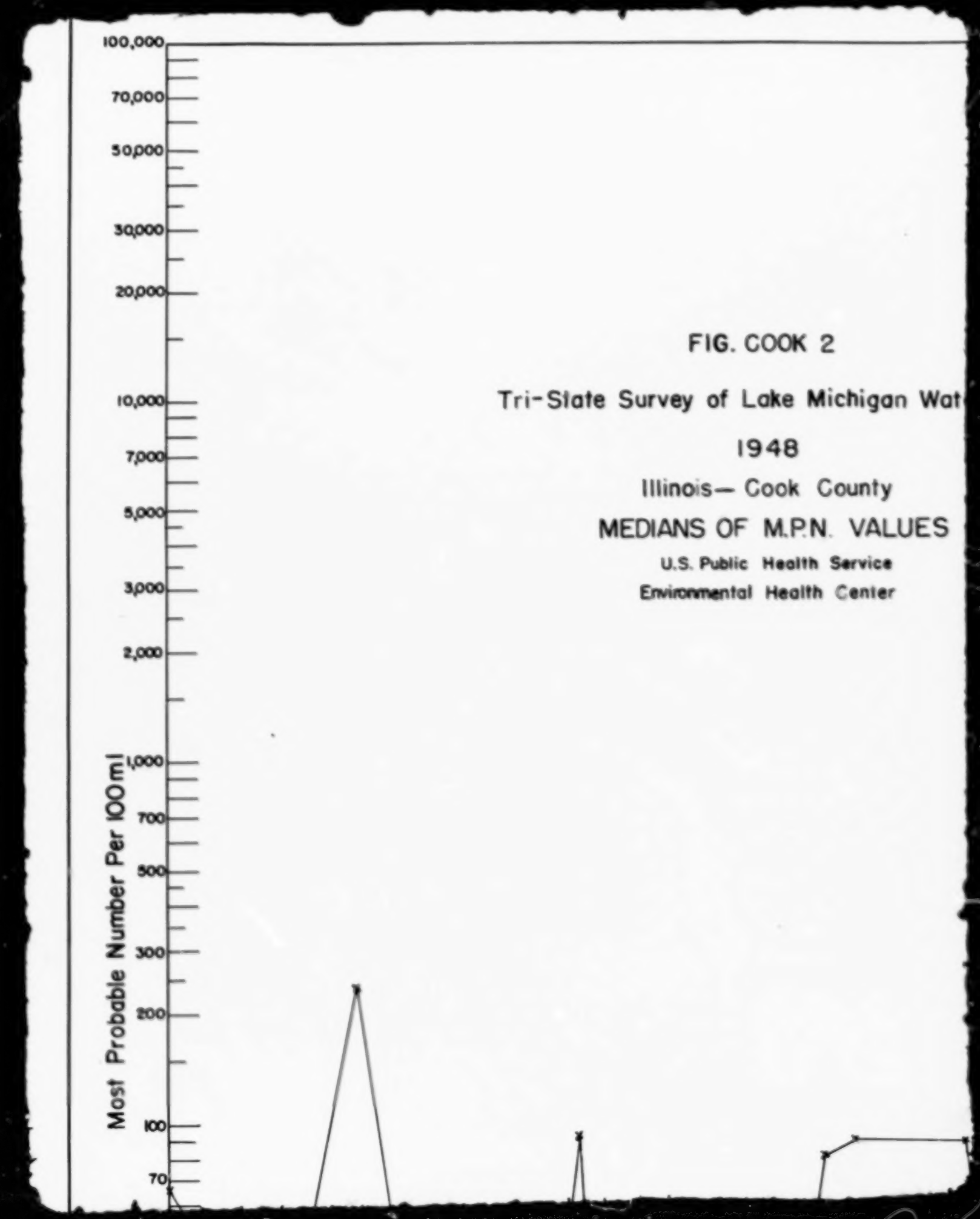
Tri-State Survey of Lake Michigan Waters
Relation of Coliform & Enterococcus

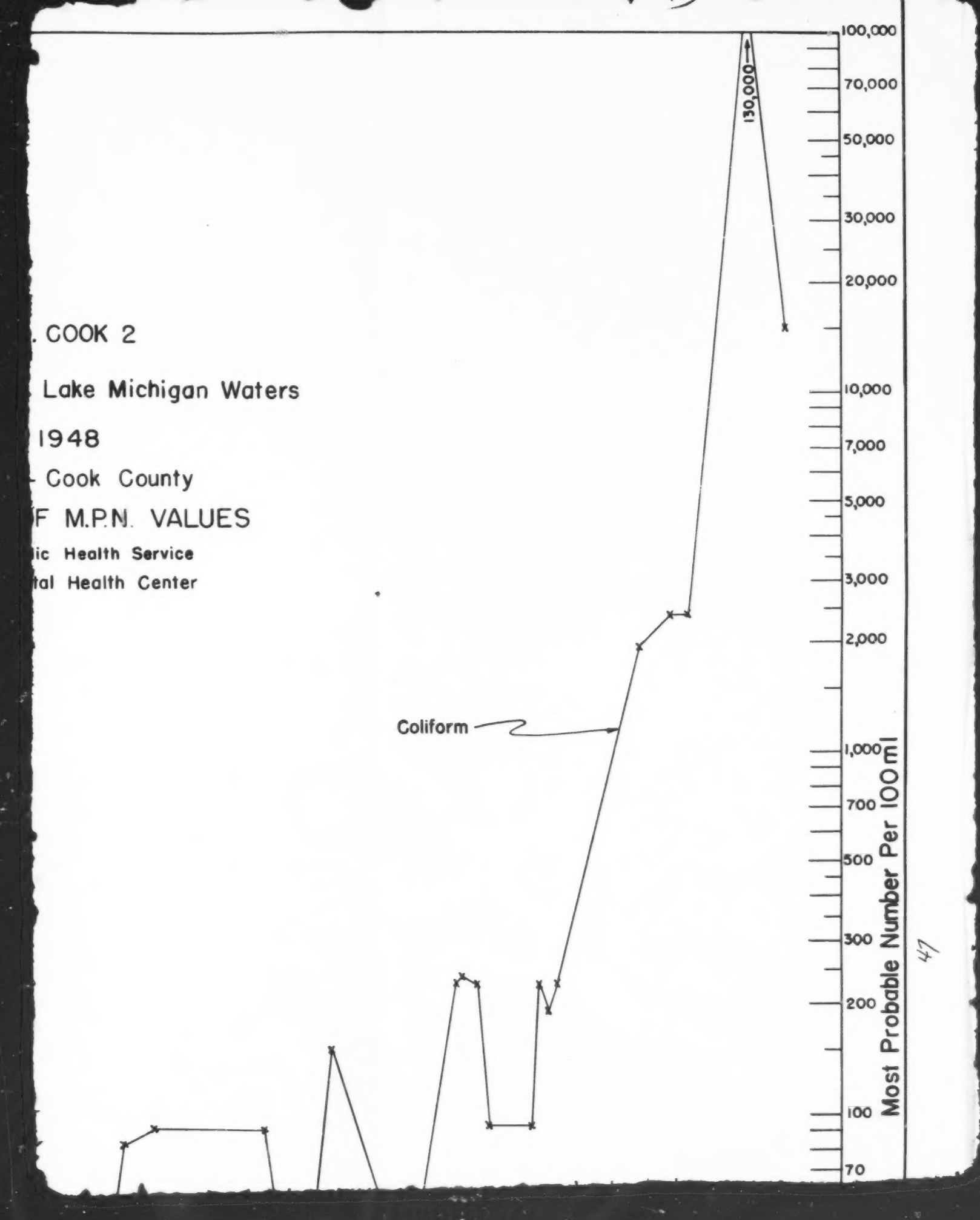
Illinois – Cook County

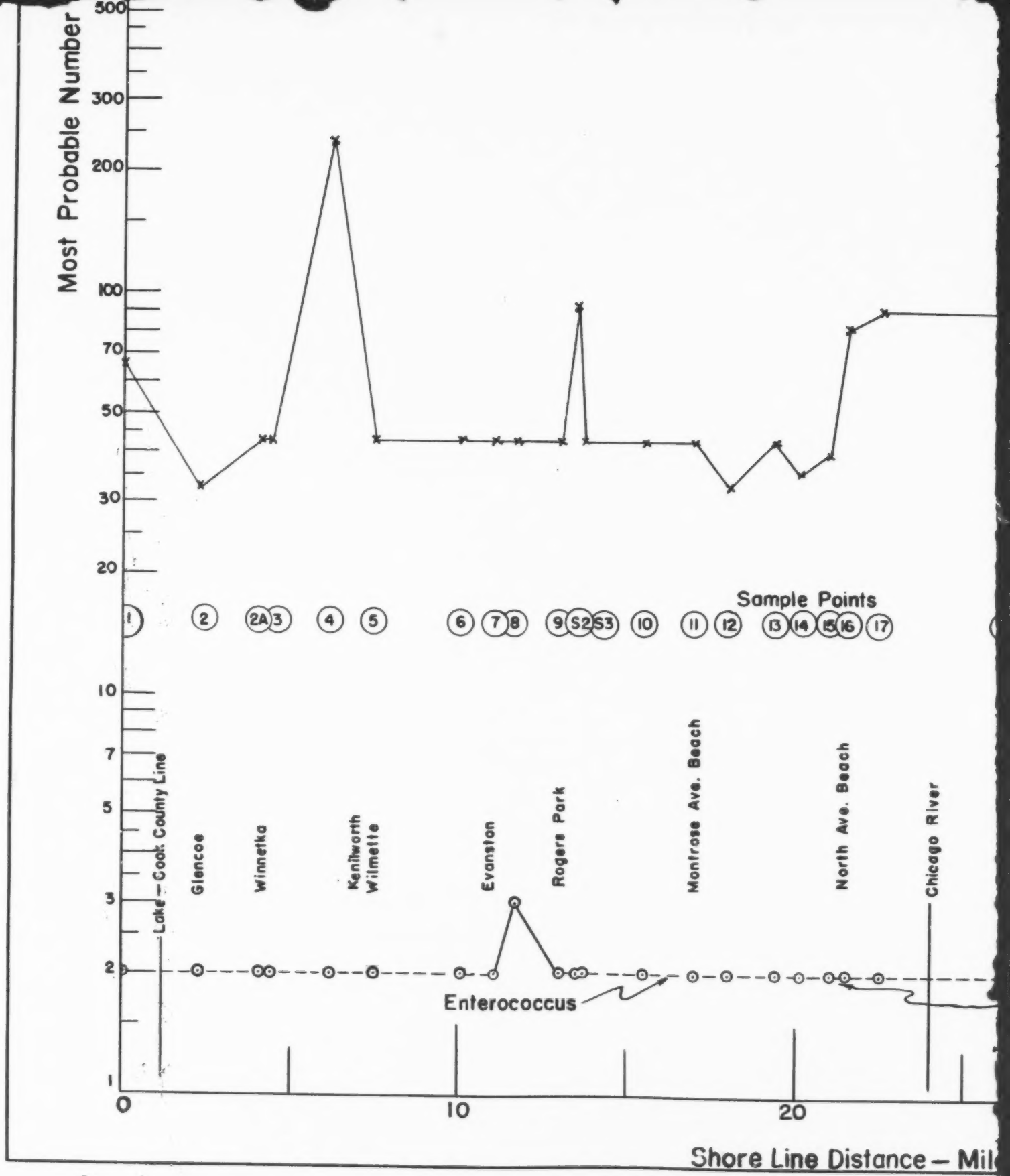
June – July – August

U.S.P.H.S.
Cincinnati, Ohio

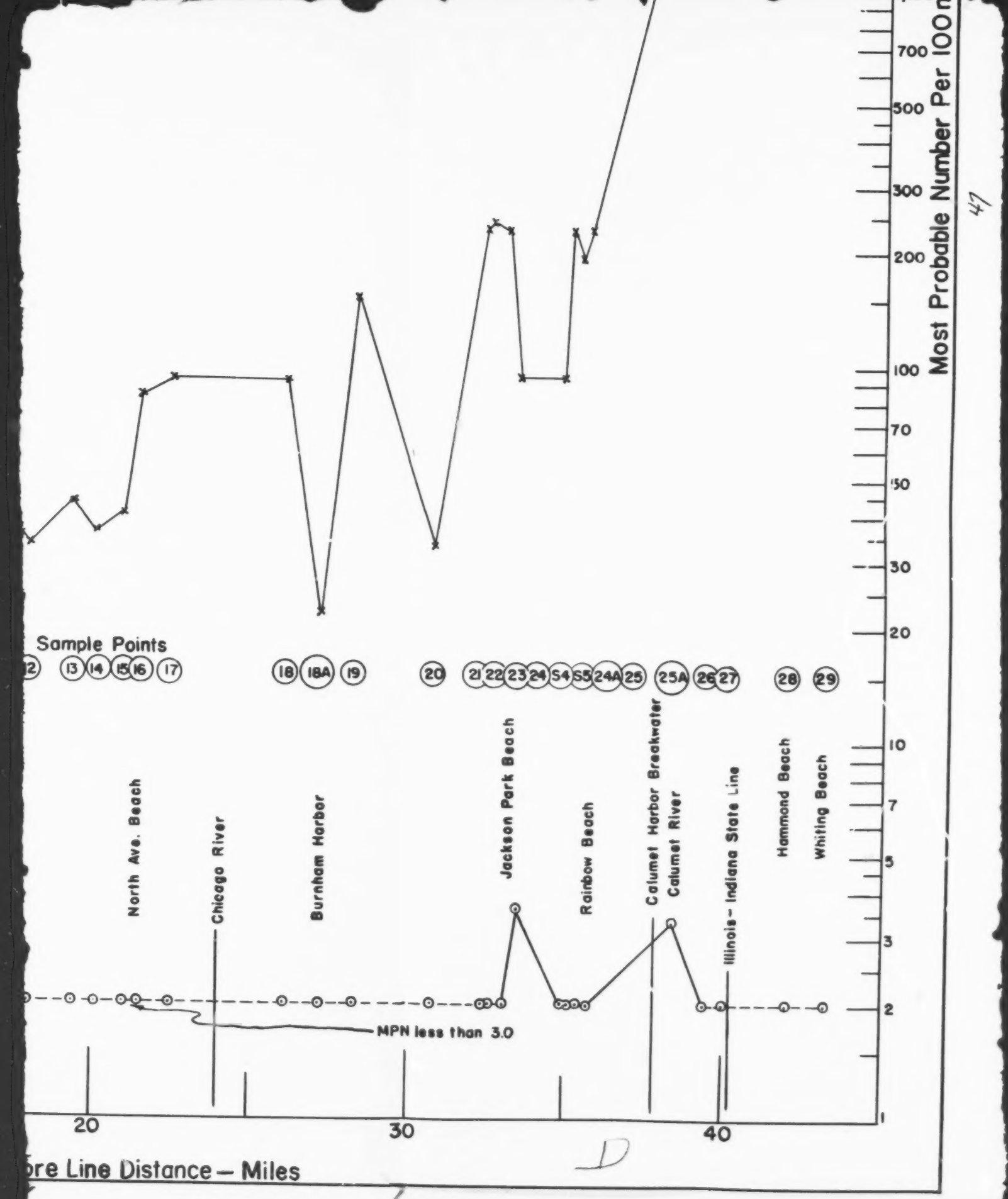
Environmental Health Center
December 1948


100,000
70,000
50,000
30,000
20,000
10,000
7,000
5,000
3,000
2,000
1,000
700
500
300
200
100
70
Most Probable Number Per 100 ml
FIG. COOK 2
Tri-State Survey of Lake Michigan Wat
1948
Illinois— Cook County
MEDIANS OF M.P.N. VALUES
U.S. Public Health Service
Environmental Health Center


. COOK 2
Lake Michigan Waters
1948
- Cook County
F M.P.N. VALUES
ic Health Service
tal Health Center
Coliform
130,000
100,000
70,000
50,000
30,000
20,000
10,000
7,000
5,000
3,000
2,000
1,000
700
500
300
200
100
70
Most Probable Number Per 100 ml


Most Probable Number
500
300
200
100
70
50
30
20
10
7
5
3
2
1
Sample Points
1
2
2A
3
4
5
6
7
8
9
S2
S3
10
11
12
13
14
15
16
17
Lake – Cook County Line
Glencoe
Winnetka
Kenilworth
Wilmette
Evanston
Rogers Park
Montrose Ave. Beach
North Ave. Beach
Chicago River
Enterococcus
0
10
20
Shore Line Distance – Mil

C


Most Probable Number Per 100ml
700
500
300
200
100
70
50
30
20
10
7
5
3
2
1
Sample Points
12
13
14
15
16
17
18
18A
19
20
21
22
23
24
S4
S5
24A
25
25A
26
27
28
29
North Ave. Beach
Chicago River
Burnham Harbor
Jackson Park Beach
Rainbow Beach
Calumet Harbor Breakwater
Calumet River
Illinois - Indiana State Line
Hammond Beach
Whiting Beach
MPN less than 3.0
20
30
40
ore Line Distance — Miles

DISCUSSION

The laboratory results indicate a very sharp line of demarkation in the sanitary quality (based on coliform MPN) of the shore waters north and south of the Calumet Harbor breakwater at 85th Street.

Area North of Calumet Harbor Breakwater

During the bathing season, all of the beaches in this area were open for bathing.

Over the period from June 1 to August 29, the coliform densities of the beach waters in this area were reasonably low with only 51 of 1075 routine samples having a coliform MPN over 1100 per 100 ml. Only two of the beaches had 20 percent or more samples with a coliform MPN over 460. These were Elder Lane Park Beach in Winnetka at the north end of the area where a bathhouse was under construction and Jackson Park Beach near the south end. Elder Lane Park was the only beach in this area that had more than 15 percent of the samples with a coliform MPN over 1100 per 100 ml. Parallel tests for enterococcus showed that 862 or 80 percent of the samples had an MPN of 3.6 or less and that only 41 or 3.8 percent had an MPN in excess of 43 per 100 ml.

Area South of Calumet Harbor Breakwater

In this area only two beaches in Illinois, both in Calumet Park, are used for bathing. Only one of these is an organized bathing beach provided with bathhouse facilities and life guards.

Coliform densities on these Calumet Park beaches were much greater than those for the shore waters in the remainder of Cook County. Of the 79 samples taken on these two beaches, 48 or 61 percent had an MPN over 1100 and 19 or 24 percent had an MPN over 10,000. The enterococcus density in this area was slightly lower than that in the northern area as 89 percent of the samples had an MPN of 3.6 or less and only 2.5 percent had an MPN in excess of 43.

The Calumet Park beaches were closed on July 23, 1948, by order of the Chicago Park District on the resolution of the Advisory Board of the Tri-State Survey dated July 23, that swimming in this area was "not recommended".

Frequency of Bacteriological Sampling

As noted in the General Summary, there were marked fluctuations in the coliform, and to a less extent in the enterococcus, densities of the samples taken from the same beach on different days. Although some of these fluctuations were common to nearly all the beaches along the Cook County lake front, others would be shown only on individual beaches. It is not possible to forecast the time of such shifts in density. The following table shows how greatly the most probable number of coliforms and enterococci fluctuated on three widely separated beaches during the ten day period from July 19 to July 29, and a comparison with the median values for the summer.

Sample Point	Determination	MPN / 100 ml on July 19	22	23	24	27	29	Summer Median
2	Coliform	240	240	4600	1100	23	9.1	33
	Enterococcus	-3	7.3	240	9.1	-3	3	-3
16	Coliform	43	1100	9300	93	150	—	83
	Enterococcus	3.6	43	93	-3	9.1	—	-3
24A	Coliform	2400	930	2400	—	150	430	190
	Enterococcus	-3	43	240	—	-3	3.6	-3

Individual sample points at times showed great fluctuations in coliform densities during a twelve hour period on a given beach. Examples are given for three sample points on various days.

Coliform MPN per 100 ml at Time Shown

Date	Sample Point	9AM	11AM	1PM	3PM	5PM	7PM	8PM	9PM
7/13	9	930	1500	2400	2400	4600	11,000	1500	—
7/18	9	23	430	430	75	240	93	—	93
7/25	24A	430	36	91	130	36	230	—	—
	25	230	230	150	760	2400	230	—	—
8/29	24A	150	430	2400	930	430	2400	—	4600
	25	36	150	73	430	930	430	—	430

On the basis of this evidence it would appear advisable to take samples as frequently as possible with the ideal being a daily sampling schedule. It would seem evident that no reliance should be placed on two or three isolated samples in the estimation of the sanitary quality of beach waters.

Epidemiological Survey

Two areas in Chicago, one on the north side and the other on the south side, were selected for epidemiological study in an attempt to evaluate the effects on general health of frequent bathing in waters of the quality found in these areas. It was hoped that the results would enable a start to be made on a rational standard for bathing water quality.

In each area approximately 1000 families agreed to cooperate by keeping a family record of bathing experience and sickness during a period approximating ten weeks. After the termination of the survey, seventy-nine percent of the forms were returned.

Studies of the information collected are proceeding and a report on this phase of the survey will be issued at a future date.

Appendix D

SURVEY IN INDIANA

Prepared
by
Indiana State Board of Health

CONCLUSIONS

1. Bacteriological analyses for coliform organisms confirmed conclusions of beach quality derived from sanitary surveys with the possible exception of the East Chicago beach. Here the coliform d nsity was fairly low but the sand bore evidence of oil contamination.

2. The waters at the Gary, Dunes State Park, and Michigan City public beaches were quite acceptable for bathing purposes on the basis of existing methods of rating such waters.

3. There was no correlation observed between coliform and enterococcus densities in the Indiana portion of the survey.

4. The Indiana Harbor Canal showed evidence of bacterial pollution which might be expected from the effluent of sewage treatment plants, comparatively small amounts of untreated sewage and industrial wastes, together with a substantial volume of cooling water such as are discharged to the Grand Calumet River and, in large part, returned to the lake through this canal. From the data on hand the bacterial content of the canal waters and the volume of raw sewage discharged directly to the lake from Whiting were not sufficient to account for the extremely high coliform results found on the Hammond and Whiting beaches.

5. Further sampling and or surveys are necessary to explain the prodigious coliform counts observed on various occasions on the Hammond and Whiting beaches.

SAMPLING POINTS

Seven routine sampling points were established along the forty miles of lake front in Indiana. These points were set on all of the organized public beaches used during the summer, one on a beach that had been closed for several years, and one on a bridge over the Indiana Harbor Canal. Good sand beaches extend along the entire Indiana shore east of Gary and the limits of the public beaches are not well defined. The beach sample points were located where the maximum bathing load was expected to occur.

During the period from June 23 to September 15, each of these points was sampled 17 times, samples having been taken alternately once or twice a week. Samples from the raw water intake of the Hammond water filtration plant were taken daily by plant employees and examined for coliforms in the laboratory of the filter plant.

The general location of the various sampling points is given in Table Indiana 1.

TABLE INDIANA 1

SAMPLE POINTS

R-1	Hammond - Raw water intake
1	Hammond - Lake Front Beach
2	Whiting - Municipal Beach
*3	East Chicago - Indiana Harbor Canal (Dickey Place Bridge)
4	East Chicago - Lees Park Beach
5	Gary - Marquette Park Beach
6	Tremont - Dunes State Park Beach
7	Michigan City - Washington Park Beach

*Not a shore sample

SANITARY CONDITIONS

General

The Indiana shoreline of Lake Michigan for approximately 30 miles from the Michigan State Line west to Gary receives drainage from rural areas and small towns. At East Chicago the situation changes and for five miles to the Illinois State Line the discharges which reach the lake come from industry and from one municipal sewer at Whiting.

Lake pollution in the Calumet area of Indiana was made the basis of a suit "State of Illinois v. State of Indiana, et al." before the Supreme Court in 1943 and amended in 1945. Since this latter date, abatement of pollution has progressed at an accelerated rate. Whiting was the only city named in the suit which was not treating its sanitary wastes in 1945.

Completion dates for all stipulations made by parties in the suit do not expire until 1950. Any detailed survey of, or report on, pollution in this area made before 1950 may be inaccurate by the time that it is published.

There is no known discharge of industrial waste into the lake east of the Indiana Harbor East Breakwater.

Hammond-Whiting

Hammond and Whiting each has a combined sewer system. The Hammond Sanitary District treats all of the sewage from Hammond and two-thirds of that from Whiting in an activated sludge sewage treatment plant and discharges the effluent into the Grand Calumet River. The remainder of Whiting's sewage during the period of the survey was discharged to Lake Michigan east of a jetty or short breakwater which constitutes the east boundary of the Whiting Municipal Beach. Contracts have recently been let to divert this remaining

portion of the sewage of Whiting to the Hammond Sanitary District sewage treatment plant. Storm water overflows to the lake are maintained on both sides of the Hammond-Whiting city boundary which is about 0.8 miles west of this beach.

Industrial wastes flow into the lake at both ends of the Hammond-Whiting shoreline. The waste at the extreme northwest end originates at the plant of the American Maize Products Company. Sanitary sewage from this plant is discharged to the Hammond city sewers. Under its stipulation to the Supreme Court, however, the company is permitted to discharge to the lake approximately 300 pounds of corn sugar per day along with several million gallons of indirect process water which has been used in part for cooling purposes. It is expected that installation of equipment now on hand, and some yet to be ordered, will reduce the amount of corn sugar waste substantially below the figure stated in the stipulation. This rather unusual trade waste may have a stimulating effect on the growth of coliform organisms in the lake out of proportion to its sanitary significance.

At the other end of this segment of the shoreline the Standard Oil Company discharges considerable quantities of process water through oil separators. Sanitary sewage was formerly discharged through the same outfalls; however, the company's program of installing a separate sanitary sewer system was reported 94% complete by July 31, 1948. All of these sanitary wastes now empty into the Whiting municipal sewers.

The Lake Front Beach at Hammond has been closed for a number of years because of the high coliform counts.

East Chicago (Indiana Harbor)

The effluents from the activated sludge sewage treatment plants at Hammond, East Chicago, and Gary, together with much of the industrial waste from the area, discharge into the Grand Calumet River. A large portion of the flow in this river goes into the lake through the Indiana Harbor Canal while the balance, estimated at less than 20%, flows westerly through portions of the Little Calumet River into the channel system of The Sanitary District of Chicago and finally into the Illinois River. The Carnegie-Illinois steel mills and the Gary sewage treatment plant are located east of the Indiana Harbor Canal; the Hammond and East Chicago sewage treatment plants are located west. Cooling water flow from the steel mills is estimated at from 500 to 620 c.f.s. and Gary contributes more than 30 c.f.s. as sewage treatment plant effluent. It is believed that at least the dry weather flow from the Hammond and East Chicago sewage treatment plants (approximately 50 c.f.s.) flows westerly away from the Indiana Harbor Canal, although there is no doubt that lowered lake levels or surcharges of storm water runoff, can reverse the stream and make it discharge through the canal.

Lees Park Beach at East Chicago is located immediately east of the Inland Steel Company mills which extend approximately 1.8 miles into the lake on the east side of Indiana Harbor. The only known potential source of pollution in this area east of the Inland Steel mills is the effluent from a

complete sewage treatment plant at the Universal Atlas Cement Company plant 1.1 miles to the southeast. Evidences of oil on the sand indicate that floating material from the industrial area to the west is carried by current and wind action out beyond the mills, and then back to shore when the wind changes.

Gary

The sewage from the city of Gary is treated at an activated sludge plant and the effluent is discharged into the Grand Calumet River. Industrial wastes from the steel mills are discharged to the Grand Calumet River. The municipal beach at Marquette Park is located approximately three miles east of downtown Gary and the industrial area. There are no known sources of pollution of Lake Michigan in this area.

Dunes State Park

This area, about ten miles east of Marquette Park in Gary, is an area of sand dunes and beaches, with practically no permanent population along the lake shore and no industry. With the exception of the west end of the state park where the guarded bathing beach is located, there is no concentration of summer visitors and the lake shore is essentially in a natural state. Septic tank and cesspool overflows from approximately 65 dwelling units in the area south of the park are discharged to road ditches from which they are flushed into Dunes Creek, a small stream which discharges to the lake at the park bathing beach. Pending a more permanent solution of the problem, the stream was chlorinated during the summer of 1948 at a point about 15 minutes flow time above the mouth. Effluent from the park sewage treatment facilities is absorbed on natural sand beds.

Michigan City

Trail Creek flows into the lake at Michigan City and the dredged mouth of the creek forms the harbor which is protected by east and west piers and an outer breakwater. The creek receives the effluent from the municipal activated sludge sewage treatment plant, storm water overflows from interceptor sewer diversion structures, and raw sewage or septic tank effluent from a few isolated buildings. The municipal bathing beach at Washington Park is located several hundred yards east of the east pier which extends 1000 feet out from shore.

LABORATORY EXAMINATIONS

During the period from June 23 to September 15, a total of 119 samples were collected from the seven sampling points in the Indiana section of the Lake Michigan shore. In general, samples were collected once or twice a week, usually on Wednesday of one week and Monday and Thursday of the following week. The most probable number of coliforms were determined on all samples and the enterococcus density on 85 of them. Ninety-one samples were taken from the intake of the Hammond water filtration plant and the most probable

number of coliforms determined in the filtration plant laboratory.

The results are presented in the form of an MPN distribution table for both coliform and enterococcus in Table Indiana 2 and graphically in Figure Indiana 1. Table Indiana 3 shows the maximum, minimum and median MPN of both coliform and enterococcus and the logarithmic average of the coliform MPN for each sample point. In Figure Indiana 2 the median MPN values are plotted against shoreline distances.

TABLE INDIANA 2

BACTERIOLOGICAL RESULTS

FREQUENCY DISTRIBUTION

Sample Point	COLIFORM					ENTEROCOCCUS				
	Number Samples Tested	Percent of Samples with *MPN over				Number Samples Tested	Percent of Samples with *MPN over			
		240	460	1100	10,000		3.6	10	43	240
R-1	91	93.5	89.1	78.1	34.1	0	—	—	—	—
1	17	100.0	94.0	94.0	70.6	11	27.2	18.2	9.1	0.0
2	17	94.1	88.2	76.5	58.8	11	0.0	0.0	0.0	0.0
3	17	100.0	100.0	100.0	47.1	9	66.7	55.5	11.1	0.0
4	17	47.1	23.6	11.8	0.0	9	0.0	0.0	0.0	0.0
5	17	23.5	0.0	0.0	0.0	11	18.2	9.1	0.0	0.0
6	17	11.8	5.9	0.0	0.0	17	11.8	11.8	0.0	0.0
7	17	17.7	5.9	5.9	0.0	17	17.6	11.8	0.0	0.0

*MPN - Most probable number per 100 ml

TABLE INDIANA 3

BACTERIOLOGICAL RESULTS

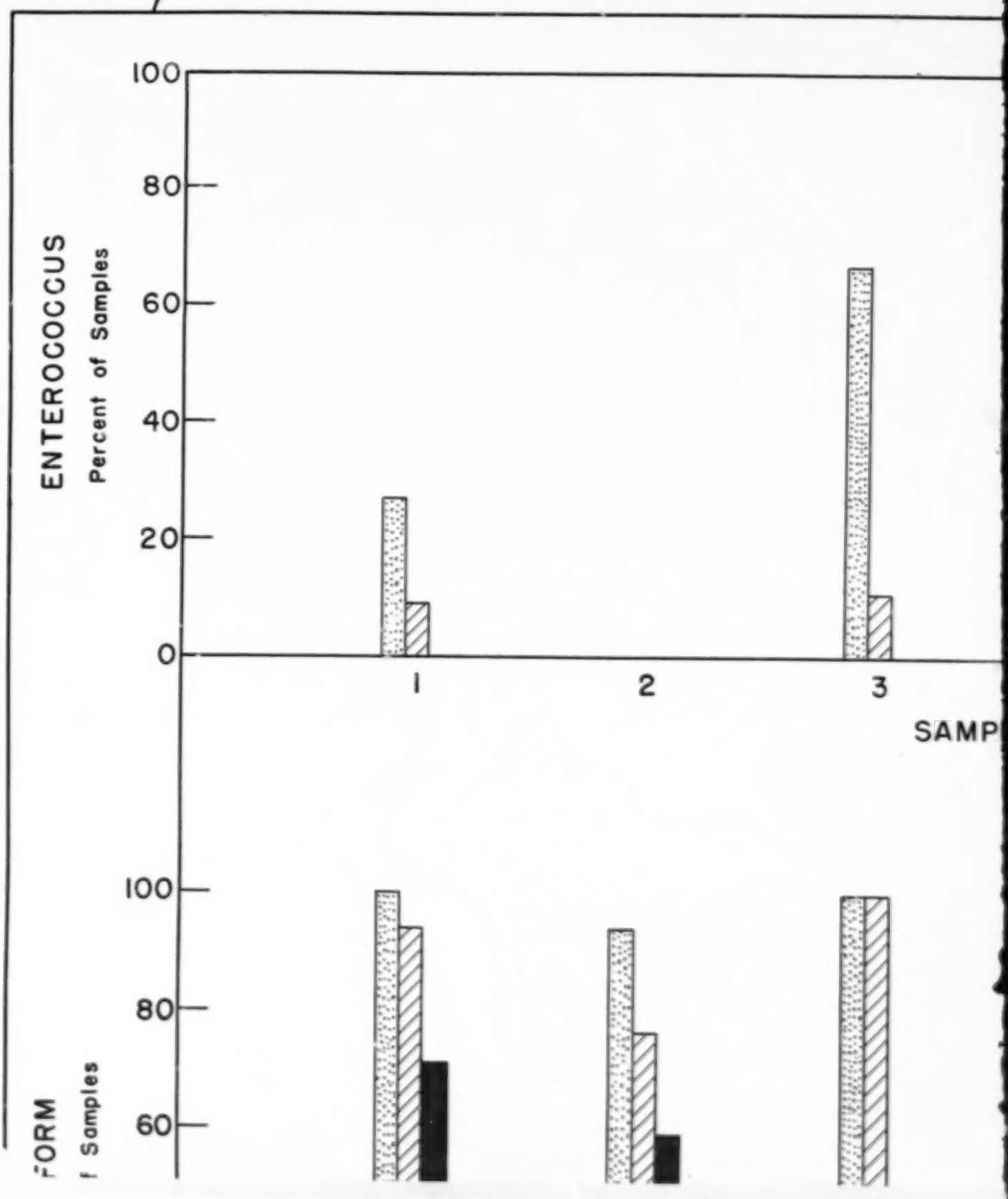
DENSITIES

MPN per 100 ml

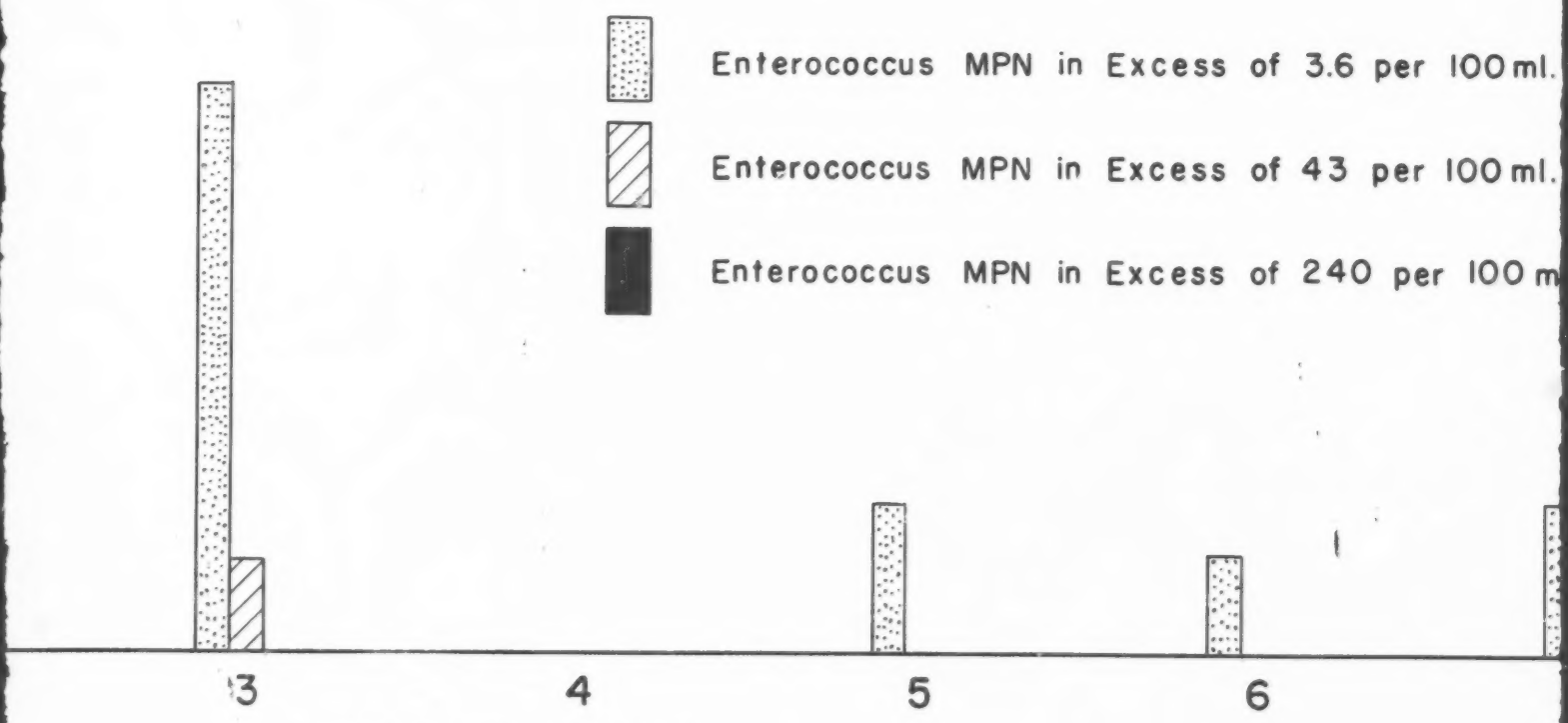
Sample Point	COLIFORM				ENTEROCOCCUS		
	Maximum	Minimum	Median	Log Average	Maximum	Minimum	Median
R-1	160,000	130	4,900	--	—	—	—
1	+11,000,000	430	110,000	65,200	93	-3	-3
2	2,400,000	230	15,000	16,900	240	-3	-3
3	110,000	2,300	9,300	13,200	93	-3	15
4	2,300	3.6	230	243	-3	-3	-3
5	460	21	150	130	15	-3	-3
6	930	-3	43	51	23	-3	-3
7	2,400	9.1	93	113	23	-3	-3

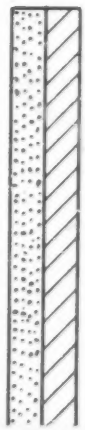
- indicates MPN indeterminate, but less than figure given

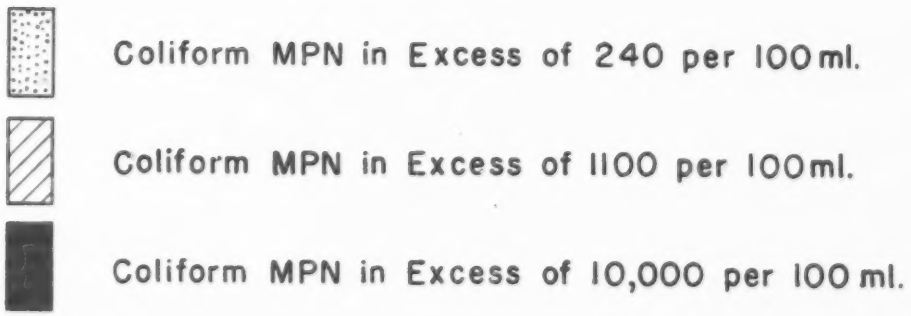
+ indicates MPN indeterminate, but greater than figure given

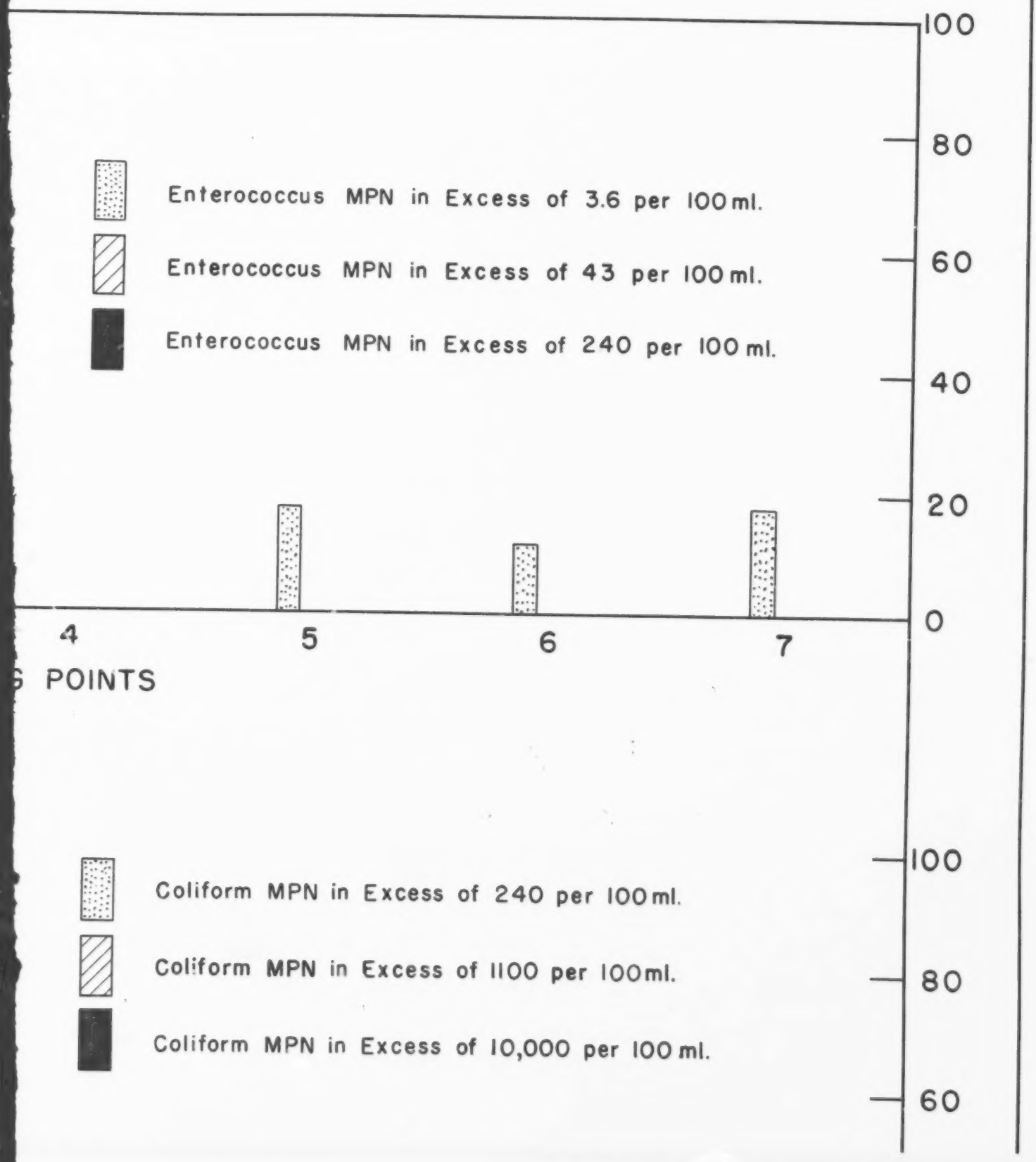

ENTEROCOCCUS
Percent of Samples
100
80
60
40
20
0
1
2
3
SAMP
FORM
Samples
100
80
60

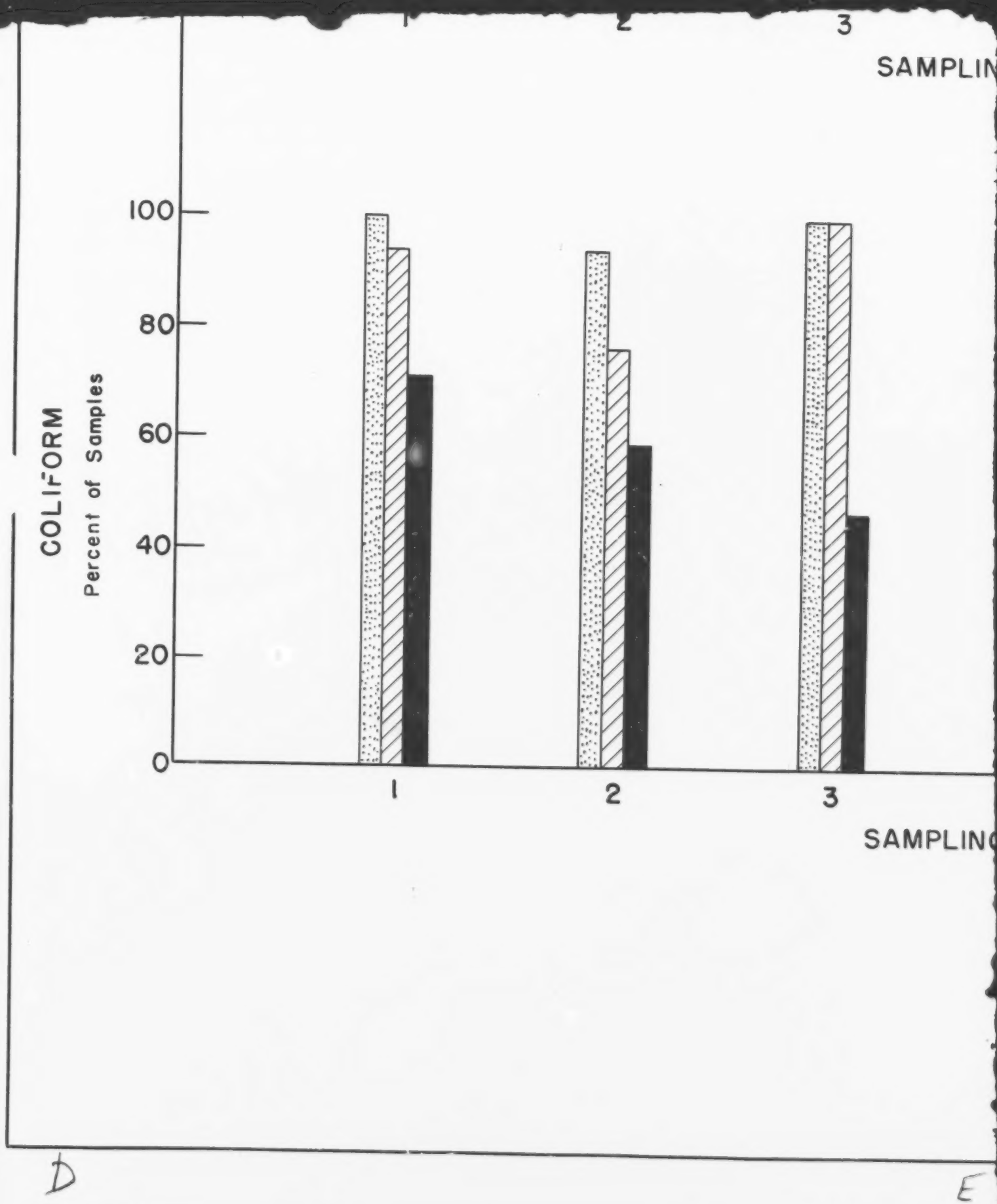
B


Enterococcus MPN in Excess of 3.6 per 100 ml.
Enterococcus MPN in Excess of 43 per 100 ml.
Enterococcus MPN in Excess of 240 per 100 m
3
4
5
6
SAMPLING POINTS



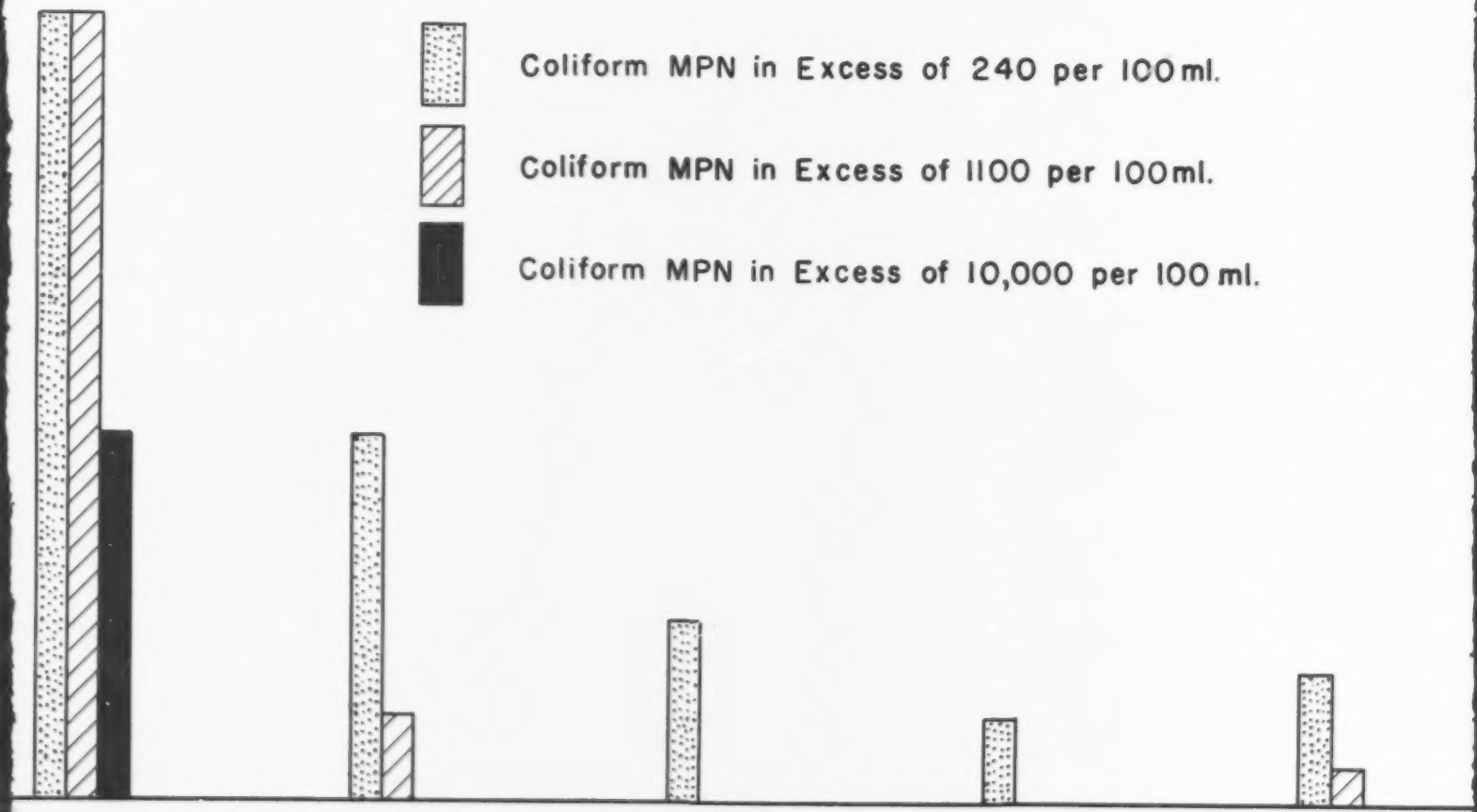

Coliform MPN in Excess of 240 per 100 ml.
Coliform MPN in Excess of 1100 per 100 ml.
Coliform MPN in Excess of 10,000 per 100 ml.


Enterococcus MPN in Excess of 3.6 per 100 ml.
Enterococcus MPN in Excess of 43 per 100 ml.
Enterococcus MPN in Excess of 240 per 100 ml.
100
80
60
40
20
0
4
5
6
7
POINTS
Coliform MPN in Excess of 240 per 100 ml.
Coliform MPN in Excess of 1100 per 100 ml.
Coliform MPN in Excess of 10,000 per 100 ml.
100
80
60


1
2
3
SAMPLIN
100
80
60
40
20
0
COLIFORM
Percent of Samples
1
2
3
SAMPLING
D
E

3 4 5 6 7

SAMPLING POINTS


Coliform MPN in Excess of 240 per 100 ml.
Coliform MPN in Excess of 1100 per 100 ml.
Coliform MPN in Excess of 10,000 per 100 ml.
3
4
5
6
7

SAMPLING POINTS

FIG. INDIANA I

Tri-State Survey of Lake Michigan Wate
Relation of Coliform & Enterococcus

Indiana

July - August

U.S.P.H.S.
Cincinnati, Ohio

Environmental Health Center
December 1948

E

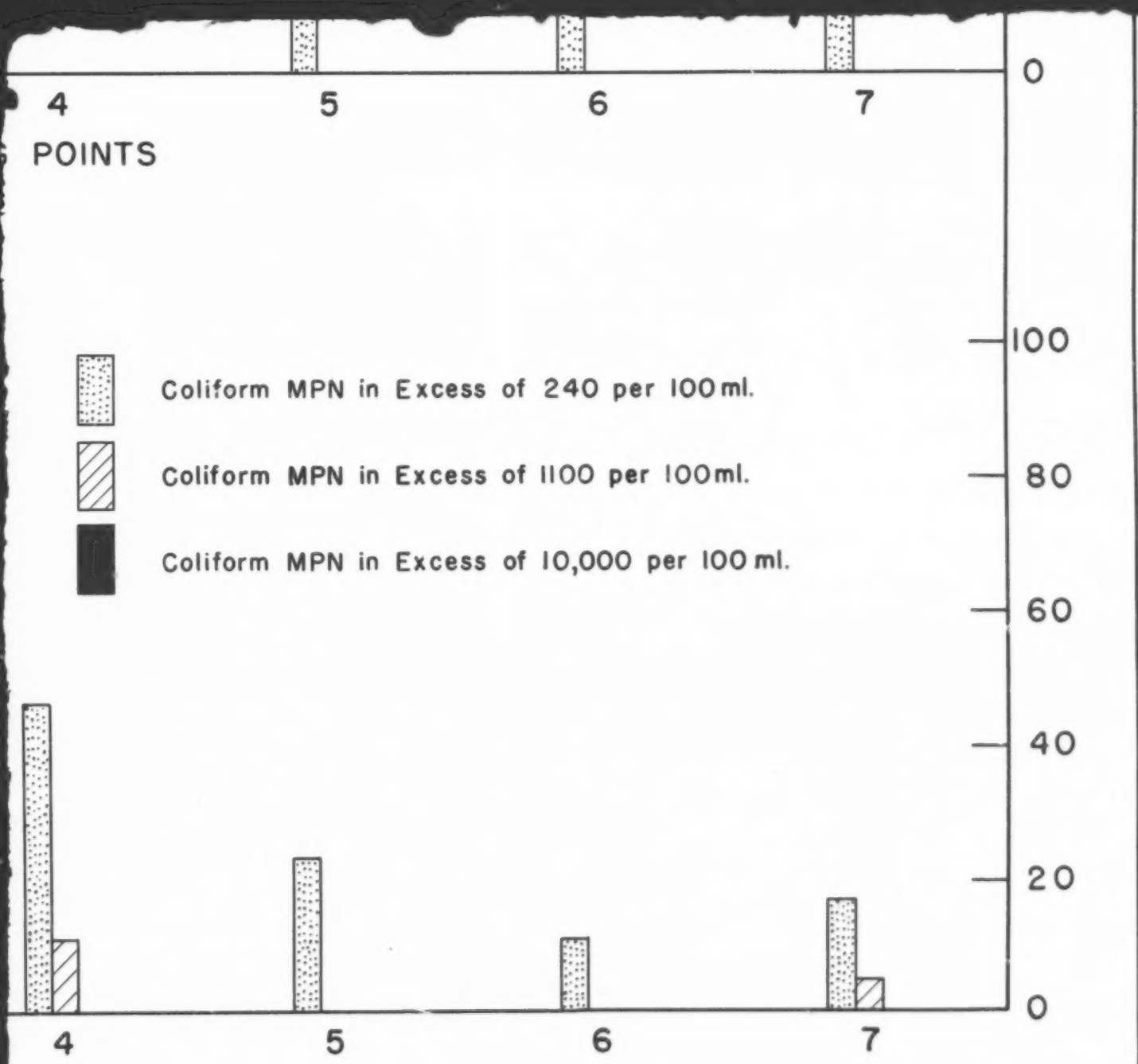


FIG. INDIANA I

Tri-State Survey of Lake Michigan Waters
Relation of Coliform & Enterococcus

Indiana

July - August

U.S.P.H.S.
Cincinnati, Ohio

Environmental Health Center
December 1948

58

F

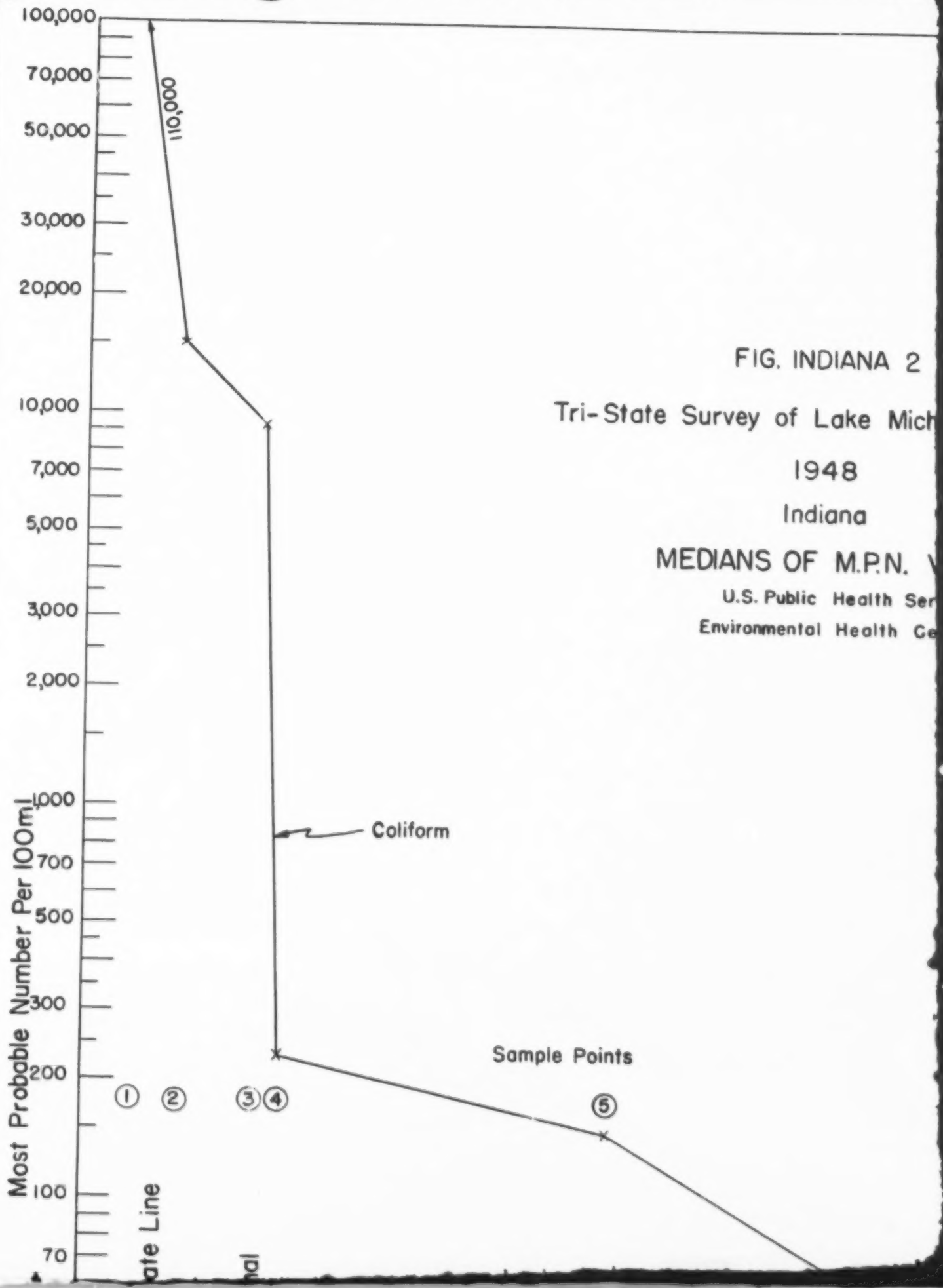


FIG. INDIANA 2

Tri-State Survey of Lake Mich

1948

Indiana

MEDIANS OF M.P.N. V

U.S. Public Health Ser

Environmental Health Ce

FIG. INDIANA 2

Survey of Lake Michigan Waters

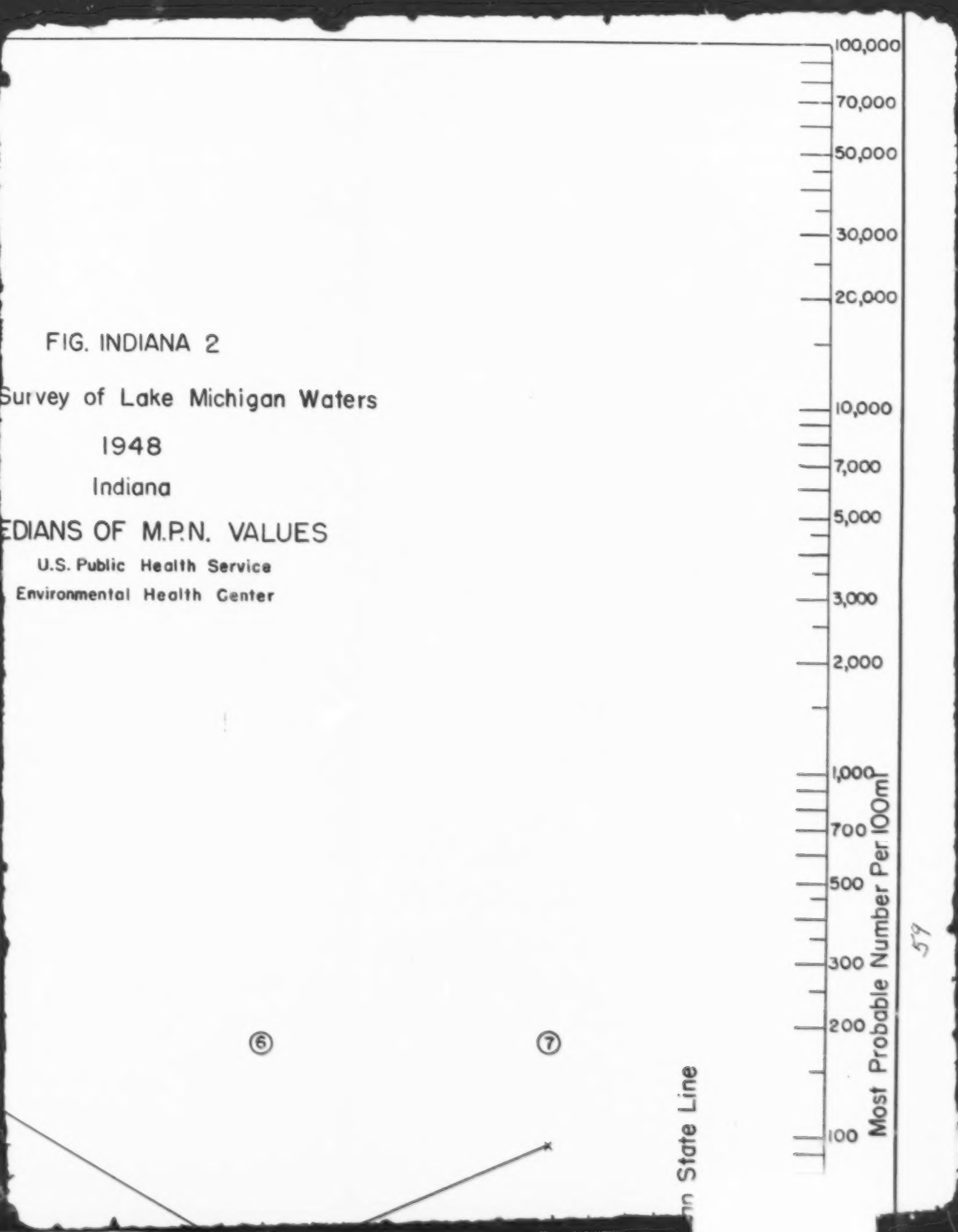
1948

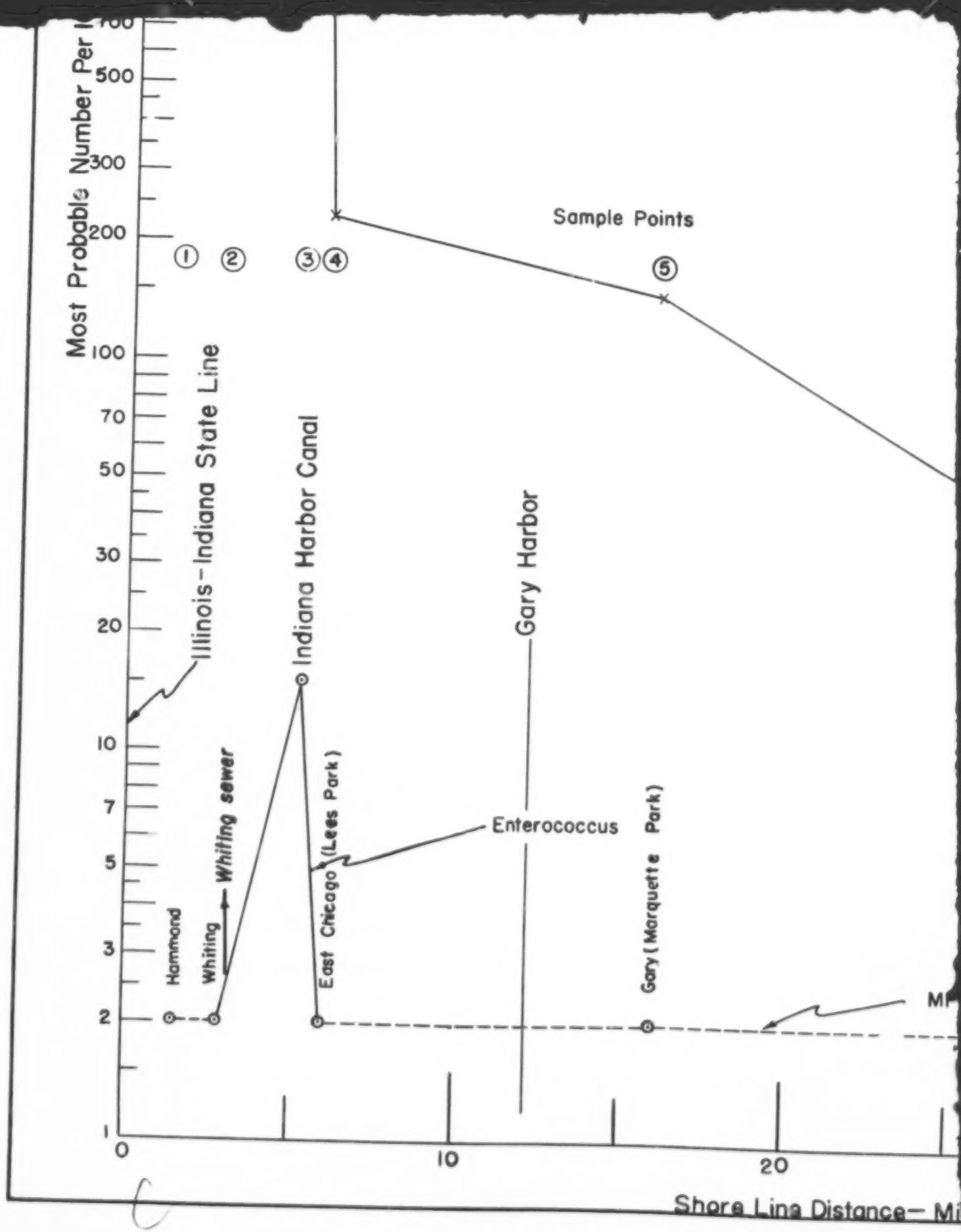
Indiana

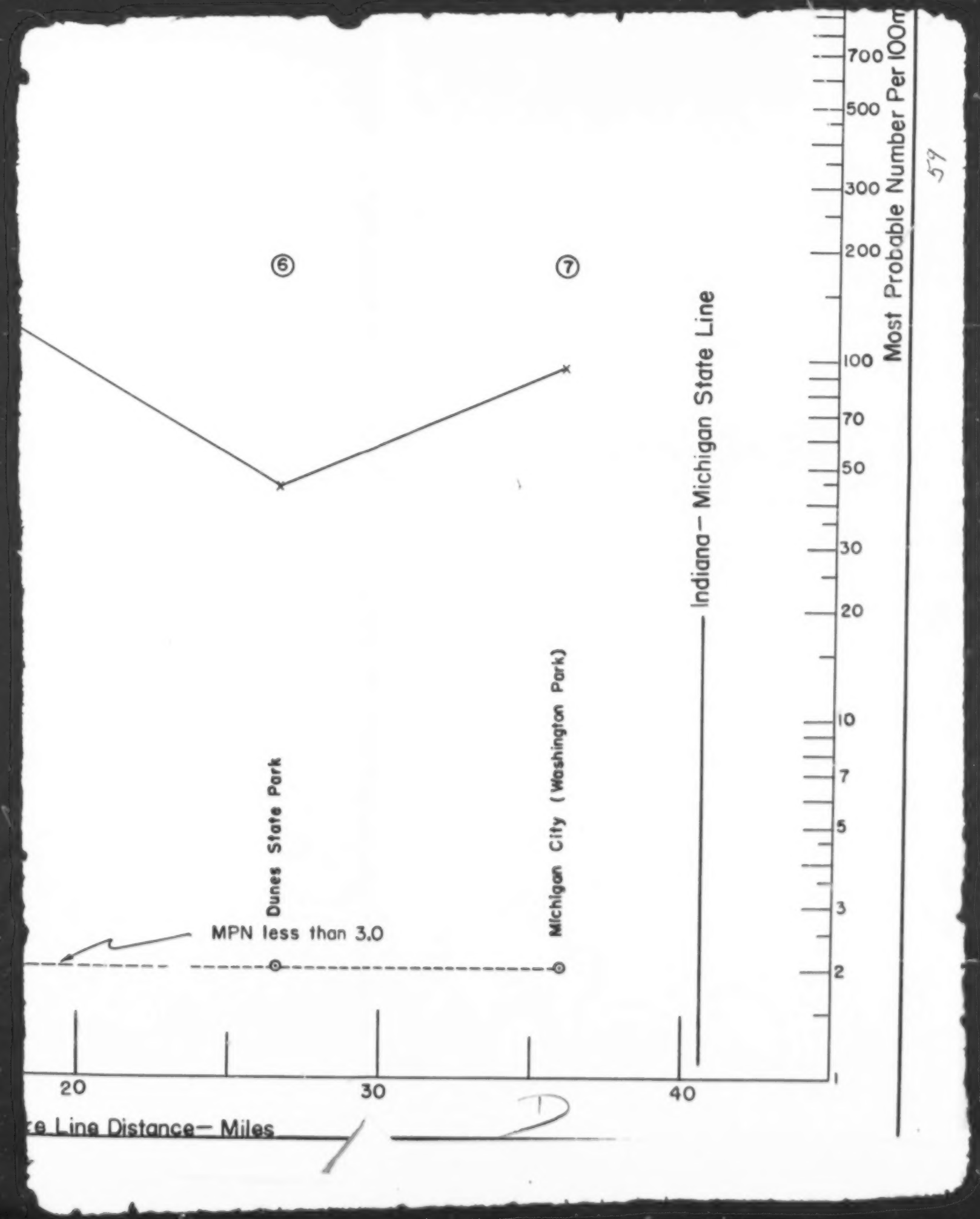
EDIANS OF M.P.N. VALUES

U.S. Public Health Service

Environmental Health Center




Most Probable Number Per
500
300
200
100
70
50
30
20
10
7
5
3
2
1
0
10
20
Sample Points
①
②
③④
⑤
Illinois-Indiana State Line
Indiana Harbor Canal
Gary Harbor
Hammond
Whiting
Whiting sewer
East Chicago (Lees Park)
Enterococcus
Gary (Marquette Park)
Shore Line Distance- Mi


⑥
⑦
Indiana– Michigan State Line
Most Probable Number Per 100m
700
500
300
200
100
70
50
30
20
10
7
5
3
2
1
Dunes State Park
Michigan City (Washington Park)
MPN less than 3.0
20
30
40
ce Line Distance– Miles

DISCUSSION

The bacteriological results presented indicate a marked change in water quality east and west of the Inland Steel Company plant on the east side of Indiana Harbor. This change illustrates the effect of a long breakwater serving to carry pollution well out from shore for diffusion in the open lake. Although Lees Park Beach at East Chicago cannot be considered free from pollution, there is no known contact with fresh sewage pollution. The bacteriological quality of the water is within the limits of most existing standards used for bathing waters.

It was surprising to observe many enterococcus densities of "less than 3" in the Hammond-Whiting area with coliform densities in the tens and hundreds of thousands. At Hammond 71% of the coliform densities were over 10,000 and 73% of the enterococcus, 3.6 or less; at Whiting 59% of the coliform densities were over 10,000 and none of the enterococcus exceeded 3.6. Coliform densities of as high as 11,000,000 were found in this area when the water had none of the obvious characteristics of sewage. It is postulated that the corn sugar waste from the American Maize Products Company plant may induce coliform growth in the lake itself.

GPO CE P80 8-4-48 8,000